creative computing

July 1980
vol 6, no 7
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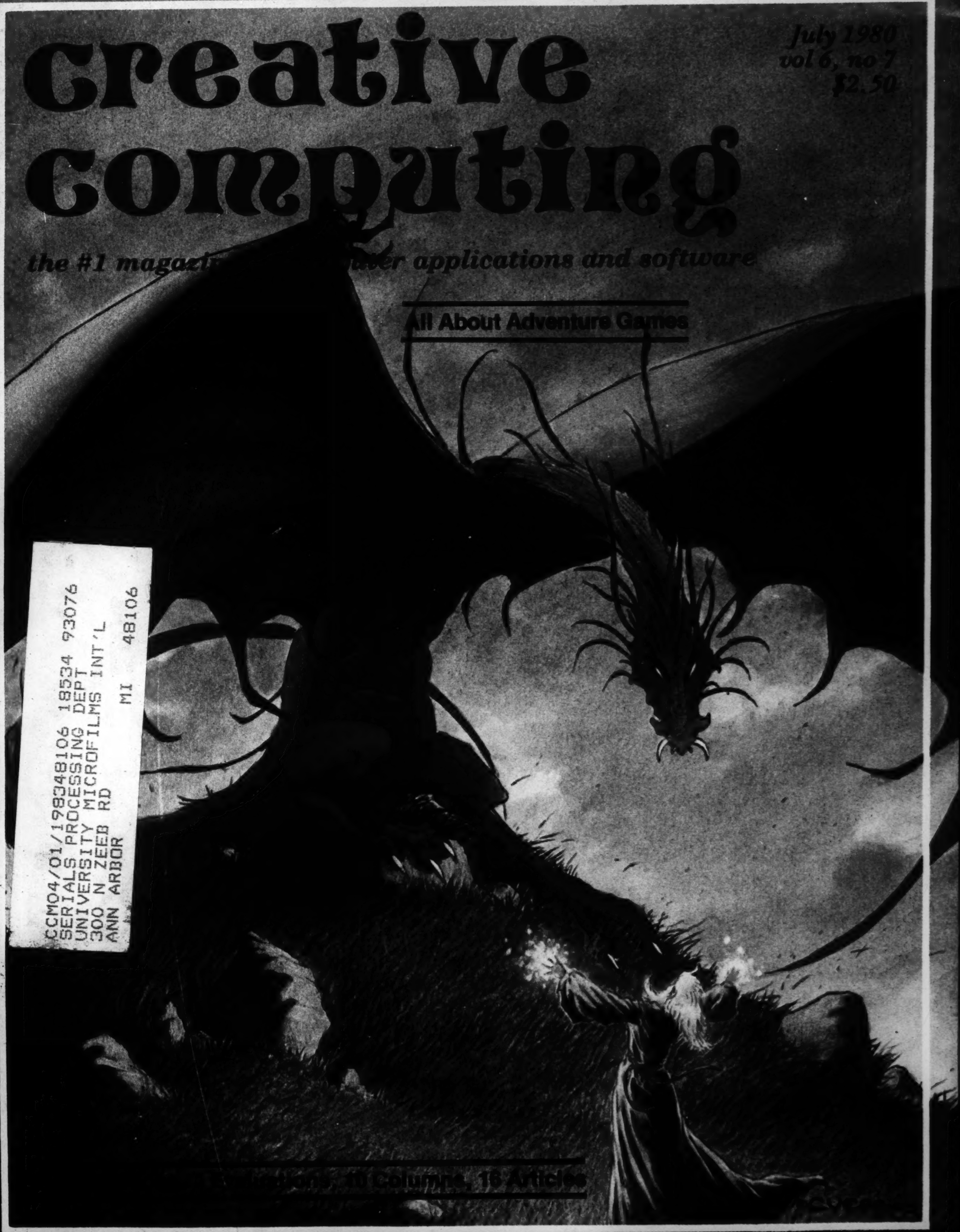
the #1 magazi[illegible]*ter applications and software*

All About Adventure Games



[illegible]tions, 10 Columns, 16 Articles

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TRS-80* Computer Compatible . . .

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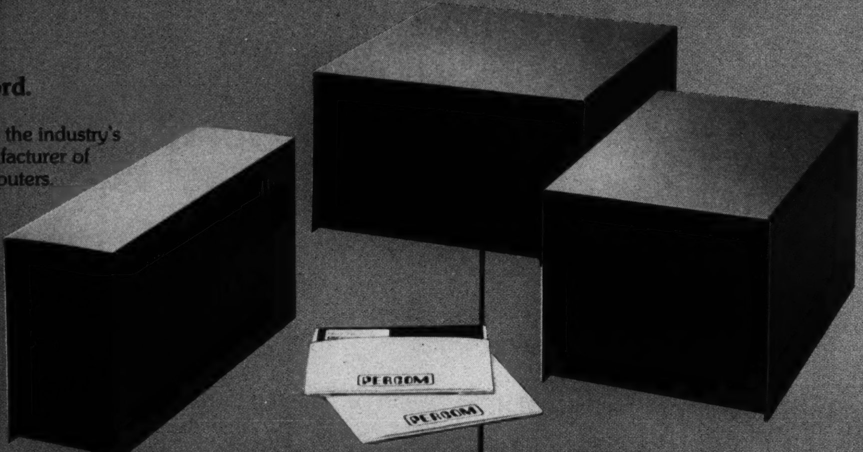

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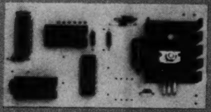
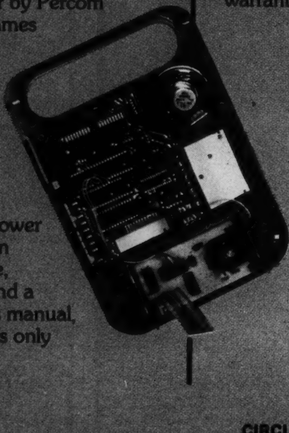
Available in 1-, 2- and 3-drive configurations, Percom drives for the TRS-80* computer start as low as $399.

The gift of speech



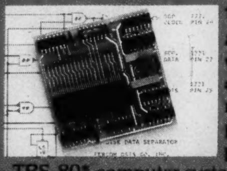
Called Speak-2-Me-2™, this clever interface module makes a Texas Instruments' Speak & Spell† the voice of your computer — announcing, imploring, commanding with expressions and sentences created from the Speak & Spell† vocabulary.

Speech is controlled either at the keyboard or by your own Level II BASIC programs. Or by Percom minidiskette word games (available soon).



Speak-2-Me-2™ is installed in the battery compartment of your Speak & Spell†, and power is provided from an ordinary calculator power pak. Supplied with an interconnecting cable, operating software and a comprehensive users manual, Speak-2-Me-2™ costs only $69.95.

the Separator:™ End "CRC error. Track locked out!"



This plug-in adapter virtually eliminates data read errors, a problem that plagues TRS-80* computer systems. The SEPARATOR™, so called, is installed in the Expansion Interface without modifying the host system. When installed, data and clock signals are reliably separated during playback, an essential function that the separator circuitry of the host computer performs very poorly. Price is only $29.95.

Note: Opening the Expansion Interface may void the Tandy limited 90-day warranty.

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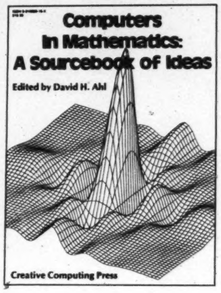

Computers
In Mathematics:
A Sourcebook of Ideas
Edited by David H. Ahl
Creative Computing Press

ALL GRADE LEVELS

Computers in Mathematics: A Sourcebook of Ideas

Here is a huge sourcebook of ideas for using computers in mathematics instruction. This large format book contains sections on computer literacy, problem solving techniques, art and graphing, simulations, computer assisted instruction, probability, functions, magic squares and programming styles.

One section presents over 250 problems, puzzles and programming ideas--more than is found in most "collection of problems" books.

Pragmatic, ready-to-use, classroom tested ideas are presented for everything from the most basic introduction to binary numbers to advanced techniques like multiple regression analysis and differential equations. Every item discussed has a complete explanation including flowcharts, programs and sample runs.

The book includes many activities that don't require a computer. And if you're considering expanding your computer facilities you'll find the section on how to select a computer complete with a microcomputer comparison chart invaluable.

Much of the material has appeared in **Creative Computing** but the back issues are no longer available. Hence this is your only source to this practical and valuable material. Edited by David H. Ahl,this mammoth 224-page softbound book costs only $15.95. (The individual issues, if they were available, would cost over $60.00). [12D]

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Computer Music Record

A recording was made of the First Philadelphia Music Festival which is now available on a 12" LP record. It features eight different computer music synthesizers programmed to play the music of J.S. Bach, J. Pachelbel, Rimsky-Korsakov, Scott Joplin, Neil Diamond, Lennon & McCartney and seven others. The music ranges from baroque to rock, traditional to rag and even includes an historic 1963 computerized singing demonstration by Bell Labs. $6.00 [CR101].

Katie AND THE COMPUTER

Katie and the Computer

Fred D'Ignazio and Stan Gilliam. This is a delightful story told in words and full color drawings of Katie's adventures when she "falls" into a computer. In Katie's journey through the land of Cybernia she meets the Software Colonel, the Bytes, the Table Manager and even a ferocious Program Bug. Her journey parallels the path of a simple command through he stages of processing in a computer, thus explaining the fundamentals of computer operation to 4-10 year olds. Supplemental explanatory information is contained in the front and back end papers. 42 pp. hardbound $6.95.

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BASIC/FORTRAN programming

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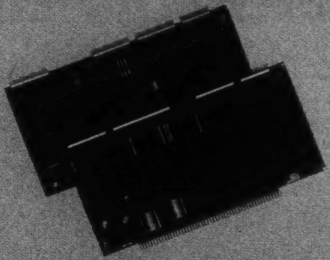

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The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.

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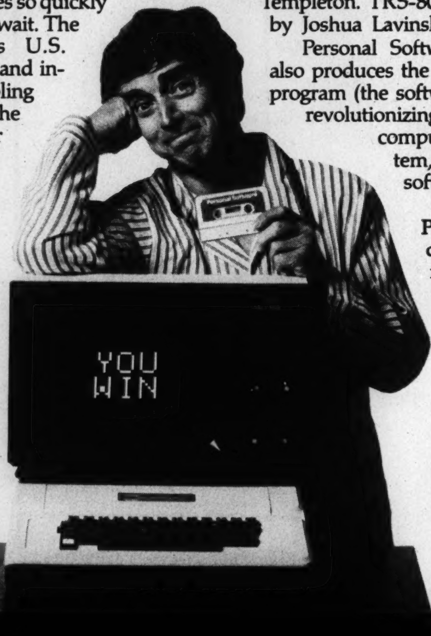
Gammon Gambler is a sure bet. With ten levels of skill, you can begin a novice and become an expert. Whichever level you play, the computer moves so quickly you don't have to wait. The program follows U.S. tournament rules, and includes the doubling cube to spice up the game. Written for the Apple and PET by Willy Chaplin.

Gammon Gambler

Checker King—you probably forgot how much fun it is! If you move and change your mind, take it back and move again—without a peep from the computer. Play eight skill levels. Add and remove pieces. Save three board positions for later play. And solve three challenging checker puzzles. Written by Michael Marks for the Apple, PET and TRS-80.

Microchess, the most widely used personal computer chess program, is a nearly perfect chess opponent for the total novice or the advanced enthusiast. Written by Peter Jennings for the Apple, PET and TRS-80.



Bridge Partner. You against the computer in over 10 million different hands of contract bridge. You can even specify the hands' high card points. Written by George Duisman for the Apple, PET and Level II TRS-80.

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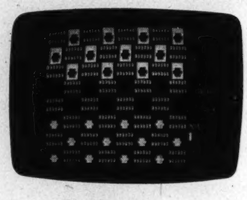

Checker King

Personal Software, Inc., also produces the VisiCalc™ program (the software that's revolutionizing personal computing), CCA Data Management System, the Vitafacts series and other exciting software for the Apple, PET and TRS-80.

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The Cover

The painting by Charles Vess depicts the conflict and dilemma of many Adventure type games. The dragon is protecting the horde of gold under the grassy knoll while the wizard (you and the computer) tries to retrieve it. (See pages 66-90).

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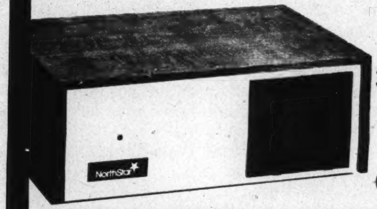

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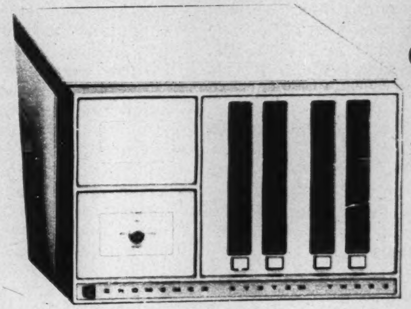

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et cetera

Corrections

Computing Trash To Treasure (May) omitted the following listings under the heading **Some Refund Publications**:

Cash Flash, Coupon Saving House, P.O. Box 46577, Dept. JM, Hollywood, CA 90046. Ed. Lynda Bettenhausen, Sample $1.50, 6 mo. $8; year, $12.

Firefly Reporter, Box 263, Dept. JM, Fulda, MN 56131. Ed, Isabelle Wetch, sample $1; 3 issues $3; 6 issues $5, year $9.

T-Ms No Form Needed Round-Up, Box 783, Dept. JM, Republic, PA 15475. Ed. Rosemary A. Mehall, single issue $2, 4 issues $7.

In our April issue, the top line of Figure 2 in Howard Bergenbon's "Word Board" should read as follows:

```
1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 0=0
```

Here's the missing program from Three Dimensional Graphics, page 129, June issue.

```
10 REM  *THREE DIMENSIØNAL PLØTTING BY CHRIS KING*
20 REM
30 REM  *INITIATE ALL VARIABLES
40 PRINT "RØTATIØN, ELEVATIØN";
50 INPUT T,A
60 PRINT"ØRIGIN ØF VIEWING (X,Y,Z)";
70 INPUT P1,P2,P3
80 PRINT"FIELD ØF VIEW";
90 INPUT F
100 T=T*1.74533E-2   '(DEGREES TØ RADIANS)'
110 A=A*1.74533E-2
120 REM  *AUTØ ØRIGIN ØF CUBE
130 Ø1=ABS(5*(SIN(T)+CØS(T)))
140 Ø2=ABS(5*CØS(T)*SIN(A)+5*SIN(T)*SIN(A)+5*CØS(A))
150 REM  *PØINT ØF VIEW ØN CARTESIAN PLAIN
160 P4=Ø1-(P1-5)*SIN(T)+(P2-5)*CØS(T)
170 P5=Ø2-SIN(A)*((P1-5)*CØS(T)+(P2-5)*SIN(T))+(P3-5)*CØS(A)
180 REM  *S--SCALING FACTØR
190 S=10000/17.5   '10000--SIZE ØF PLØTTER DØT MATRIX'
200 REM  *SCAN ALL Y LINES
210 FØR X1=0,10
220 PRINT"PLTP"   'PØSITIØN BEGINING ØF LINE (PLØT PØINT)'
230 FØR Y1=0,10,.25   'QUARTER SQUARE INCREMENTS'
240 GØSUB 400
250 IF Y1<>0 THEN 270
260 PRINT"PLTL"   'START PLØTTING LINE'
270 NEXT Y1
280 NEXT X1
290 REM  *SCAN ALL X LINES
300 FØR Y1=0,10
310 PRINT"PLTP"
320 FØR X1=0,10,.25
330 GØSUB 400
340 IF X1<>0 THEN 360
350 PRINT"PLTL"
360 NEXT X1
370 NEXT Y1
380 PRINT "PLTT"
390 STØP
400 CALL FNC3D  'DEFINE  Z1= . . .'
410 IF Z1>=0 THEN 430
420 Z1=0
430 IF Z1<=10 THEN 450
440 Z1=10
450 X2=Ø1-(X1-5)*SIN(T)+(Y1-5)*CØS(T)
460 Y2=Ø2-SIN(A)*((X1-5)*CØS(T)+(Y1-5)*SIN(T))+(Z1-5)*CØS(A)
470 D=CØS(A)*((P1-X1)*CØS(T)+(P2-Y1)*SIN(T))+(P3-Z1)*SIN(A)
480 IF D<0 THEN 520
490 X3=(X2-P4)/(F*D+1)+P4
500 Y3=(Y2-P5)/(F*D+1)+P5
510 PRINT INT(X3*S);INT(Y3*S)
520 RETURN
530 END
```

et cetera

LOCAL Program Services Available

Project LOCAL of Westwood, Mass. announces the LOCAL Associate Member Program (LAMP) to extend its computer-oriented education services beyond the area previously served. LOCAL, has been successfully helping schools in the Boston area to teach with and about computers for over a decade. LOCAL works on the premise that it makes good sense to pool instructional computing expertise and resources, and to share them among schools.

Starting July 1, 1980, various services will be provided to any school system for a flat annual fee of $750 ($650 if the system registers before August 15). This sum could be saved easily just by taking advantage of one or two services.

For more information or registration forms contact Project LOCAL, 200 Nahatan Street, Westwood, MA 02090. (617) 326-3050.

et cetera

Seventh Annual National Computer Education Institute

Jointly sponsored by Central State University of Oklahoma, the University of Massachusetts, and *Interface: The Computer Education Quarterly Journal*, two institute locations will be offered to college and high school teachers this summer. This year's new program offers the choice of two locations and dates, and a choice of five fully credited college courses. Past enrollment has been cut off at one hundred persons. The new program will double that capacity, but enrollment will still be on a first-come basis.

The first session will take place June 8th through June 20 at the Amherst, Massachusetts campus; the second session August 3rd-15th at the Edmond, Oklahoma campus.

Although there is slight variation between campuses in costs, registration fees are $100; tuition about $125. Meals and dormatory housing are provided at $145 to $225 for the two-week program.

Detailed course outlines and registration information is available from Dr. Joe M. Kinzer, Central State University, Edmond, Oklahoma, 73034, (405) 341-2980 ext. 741.

Call For Papers

Papers are being solicited for the 1981 Summer Computer Simulation Conference to be held July 21-23, 1981, in Washington, D.C. The conference theme is "Simulation: Foundations and the Future." Accepted papers will be published in bound Proceedings distributed at the Conference. Five hundred word summaries or complete drafts of original papers must be submitted by November 15, 1980 to: L. G. Culhane, The MITRE Corporation, 1820 Dolley Madison Blvd., McLean, VA 22102, (703) 827-6447.

Decoding The Label

The mailing label on each subscriber's issue of *Creative Computing* includes a number which provides information useful to both the subscriber and our circulation department. The first three letters, CCM, indicate that the subscriber should recieve *Creative Computing* magazine. Immediately following is the date of the issue the subscription expires, e.g., 11/1/1983. The fourth digit of the year is followed by the subscriber's zip code plus ten additional digits which help us to identify the specific account.

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CIRCLE 108 ON READER SERVICE CARD

Input/ Output

Dear Editor:

Continuing Chess Feedback

Dear Editor:

I read with interest the letters concerning computer chess in Input/Output of the February issue. I can only add a hearty second to the advice given by Mr. Kimmel to those with apparent problems in a chess computer they have purchased. If the customer will follow the steps outlined by Mr. Kimmel, any malfunction can be quickly corrected. Our Customer Service department is contacting Mr. Glass in order to insure that his Boris is in perfect working order.

Mr. Goldman's five move mate against Micro-Chess was very interesting, but I wonder if any of your readers have managed to play very short games against the new generation of chess computers now available. Is it possible to defeat these stronger units at their "tournament levels" quickly? And what about one machine stomping another? Enclosed is a copy of a game in which Sargon 2.5, playing on the Chafitz Modular Game System, mated the Voice Chess Challenger in 14 moves. One interesting aspect of this game is that Sargon 2.5 repeatedly passed up opportunities to capture material in order to press forward with the attack.

WHITE	BLACK	WHITE	BLACK
1 E2 - E4	C7 - C5	8 E1 - C1	D8 - C7
2 G1 - F3	E7 - E6	9 F1 - B5	C7 - D8
3 D2 - D4	C5 x D4	10 B5 x D7	D8 - C7
4 F3 x D4	B8 - C6	11 D4 - C4+	F8 x C5
5 C1 - E3	D8 - A5+	12 C3 - B5+	C7 - B8
6 B1 - C3	C6 x D4	13 E3 - F4+	E6 - E5
7 D1 x D4	E8 - D8	14 F4 x E5+ "Mate in 1"	I LOSE

(If your readers want to reproduce this game, they should be aware that the Voice plays a somewhat randomized game so it will not always play this exact game. But entering "C1" will force it to play this opening and then it will usually complete the game as described. Sargon 2.5 when put in the "BEST" mode is not randomized and therefore will always play this game once he is out of opening book. While in book, Sargon plays the various openings in about the same proportions that they are played by masters, and since this opening is a common one, Sargon 2.5 will play it often. If he plays another opening, the "RESTORE" key can by used to "take back" the opening moves and try again.)

Perhaps Creative Computing could sponsor an informal contest to see who could submit the shortest computer vs. computer game played on tournament levels.

Dan Neumayer,
Product Development Manager
Chafitz
1055 First Street
Rockville, MD 20850

Mr. Neumayer's letter confirms the preliminary reports we have heard about the strength of Boris/Sargon 2.5. The program finished seventh in the ACM's Tenth North American Computer Chess Championship, against such heavyweight competition as Chess 4.9 (which won), Belle and Duchess. David Kittinger's Mychess came in sixth. Now if we could just persuade Mr. Neumayer and Mr. Kittinger to loan us copies of their products for the Second Annual Creative Computing Microcomputer Chess Tournament...

All right...An informal contest. Submit the shortest game against one of the stronger machines or programs... either by a human or another machine and win a copy of Kimmel's chess program. Second place wins two copies.

Programmers and manufacturers are encouraged to submit their products to Contributing Editor Stephen Kimmel at 4756 S. Irvington Place, Tulsa, OK 74135 for inclusion in the next tournament. Time is now of the essence.

Stephen Kimmel

Dear Editor:

I am somewhat confused about one of your statements regarding the castled position (I/O Feb '80). If your attack was on a square the *king* moves through—then it is an illegal move and you'd better get Hyman 1400 a basic rule book of chess.

I have just received Sargon II, only played it once at level 2 and had no trouble in winning. I'm looking forward to trying level 4, which I hear is *supposed* to be about my level of play (1600). All this depends on getting A.T.C. off the screen. I have it down to 25 and holding. Try Sargon II in your next review; it may be the only time I can see it played—damn A.T.C. *

(Human 1600:AKA ATC25)
Stephen F. Smith
5127 San Vicnete Dr.
Santa Barbara, CA 93111

* Air Traffic Controller

Frogspeak?

Dear Editor:

As a reader of your magazine for the past five months, I must applaud your efforts in enlightening the (so to speak) Little Frogs in the Pond. I have read the articles and advertisements from cover to cover; I have seen five months worth of minis, personal computers, hand-helds, toys, as well as gadgets and add-ons that defy cataloging. I have read of so many versions of Basic that I must conclude that it's not very basic anymore.

However, judging from your magazine, Basic is the only language in the world. May I assure you, at this point, it's not. As the user of a somewhat larger corporate frog (NCR 8200 with IMOS-3, Cobol 74, 128K, drive disks, and various CRTs), I am suggesting that you are failing to fulfill the needs of a potentially large audience. I am referring to the untold thousands of corporate computer users; people who pay more rent, per month, for computers than many of the

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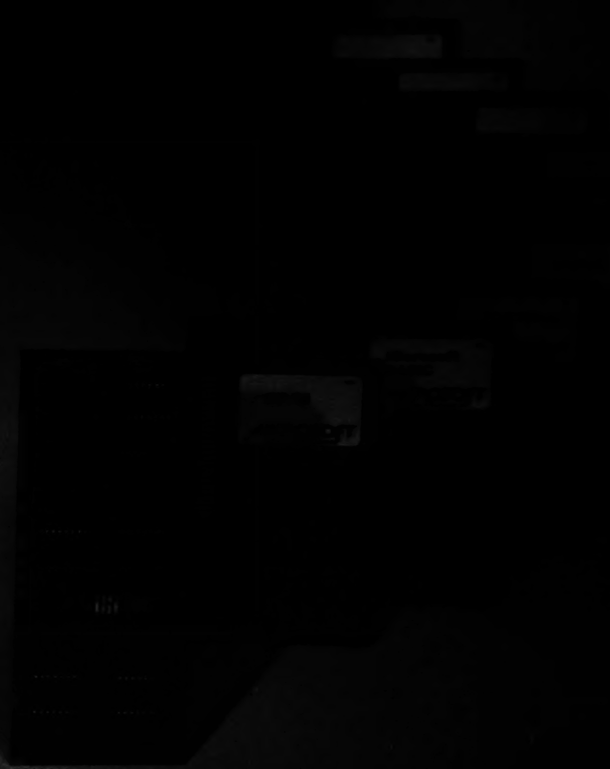

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CIRCLE 189 ON READER SERVICE

systems in your magazine cost. Believe it or not, we get bored, too. We like playing games, among other things. I'm sure that I speak for many, many other programmers when I say that, if you were to offer games in other languages, or a crash course in Basic, or conversions for Basic to other languages, or even games written in English (American will do), that your readership would have to increase.

Joseph R. Lawson
The Wurlitzer Company
Holly Springs, MS 38635

Actually, we would like to publish programs in languages other than Basic, but we'd like to avoid Fortran and Cobol because they seem like a step in the wrong direction. Software written in Pascal or C would be most welcome and might satisfy your request for readability. (We also look forward to publishing software in Smalltalk and would consider Lisp.) Unfortunately we receive almost no software written in these languages and very little is distributed commercially. —Ed.

Timed-Input Subroutine

Dear Editor:

One of the few commands left out of the TRS-80 Level II Basic is the timed-input function that most Basics have. This can come in very handy in game programs.

The solution is a very simple one, although I have never encountered it anywhere yet, so I'll pass the following little subroutine on to your readers:

```
10  INPUT "HOW MANY SECONDS TO YOU WANT
    TIMED INPUT";S
20  FOR I = 1 TO (S * 75)
30  A$ = INKEY$
40  IF A$ = "" THEN NEXT I ELSE GOTO 60
50  PRINT "OUT OF TIME" : GOTO 70
60  PRINT "YOU MADE IT IN TIME !"
70  END
```

The FOR-NEXT loop determines how long the input lasts. Press any key to give an input. If no key is pressed before the time runs out, then a message will be printed telling that time has run out. This function could very easily be incorporated into many games that are out now, to add a little excitement and challenge.

Greg Perry
6104 E. 48th St.
Tulsa, OK 74135

More On Imagination Machine

Dear Editor:

Thank you for your kind and factual article in the May issue of *Creative Computing*. It is, by far, one of the most accurate articles done on the Imagination Machine to date.

I would like to make two comments. First, it is not necessary to poke a memory location to shut the sound off while loading the tape. I will agree, it gets "somewhat tiresome after the fourth or fifth time..." however, this is solved by simply turning the volume control to "zero." This should also be done while "CSAVING," since the data load is noisy.

Second, we have improved our documentation on the Imagination Machine. We realize that supporting the machine in the consumer's hands is our responsibility. It is basically a "beginners" machine in its simplest form and for those users, we will offer for sale our "Basic Tutor." The tutor package is a 20 lesson learning tool on cassettes with a 150 page manual that will actually teach "Basic." Rather than just reading a book, the cassettes will allow the user to learn, hands-on, at his own speed. This will be available by mid-June.

For those users that are past the beginner stage, we will supply, at their request, a technical reference manual. Machine language and an explanation of how our machine works are fully covered in the TRM. In addition, we have a toll free 800 number to help the store people and consumers with any questions they may have. These phones are handled by both Sales and Technical people.

Howard R. Bollen
Executive Vice President
APF Electronics, Inc.
444 Madison Ave
New York, NY 10022

The toll-free number is 800-223-1264. —Ed.

Response From Micro Focus

Dear Editor:

Thank you for your authoritative article "Microsoft vs Micro Focus Cobol" (*Creative Computing* March 1980). It is obviously impracticable to discuss every aspect of powerful software, but we felt that your author, James McClure, achieved excellent balance in a very fair review.

His suggestions for the enhancement of CIS Cobol are closely in line with our ongoing development program. The decision to incorporate further language features is always a trade-off against available user space. However, for those who need these features, we plan a very full small-computer Cobol implementation in the relatively near future.

As to the present product, the ANSI batch Debug module has by now been implemented in CIS Cobol, an enhancement which opened the way for the recent certification of the software by the General Services Administration. Another recent addition is an implementation of CIS Cobol for the DEC LSI-11 running under RT-11, while the software has for some time been available under ISIS-II, as ICIS-Cobol from Intel. A final small point is that CIS Cobol has always permitted the incorporation of assembler language subroutines.

Your readers may be interested to know that Micro Focus has had a U.S. office since late last year. The address of this office is:

Micro Focus Inc.
1601 Civic Center Drive
Santa Clara
CA 95050
(408) 984-6961

Peter Hewitt
Micro Focus, Inc
U.K. Office: 58,
Acacia Road,
St. Johns Wood,
London NW8 6AG

Perspective on "Atari in Perspective"

Dear Editor:

I was dismayed to read the article "Atari in Perspective," in your April, 1980 issue by Len Lindsay. This piece, for which the choice of word *goofy* is perhaps too kind, hardly belongs with the generally fine quality found elsewhere in your magazine.

For years, the audio press has been laboring under advertising pressure requiring that they print "non-reviews" and useless "comparisons." One characteristic of such writing is the frequent restatement of the blatantly obvious. Mr. Lindsay's effort is perhaps even less informative than most.

In addition to the essential silliness of what he says, his writing style is itself childish. To choose one example: "The PET is one unit, designed as an all-in-one package theme." Since the terms *all-in-one, package, unit,* and *one* mean the same thing we have here a quite rare example of quadruple redundancy in a very short sentence. Too, things cannot be *designed as themes.* They can be designed *with* themes, but it is clear that the word *theme* is not appropriate here and that Mr. Lindsay has no idea what it means. As one reads through the article, other such solecisms abound, and it becomes evident that the writing is a rather accurate

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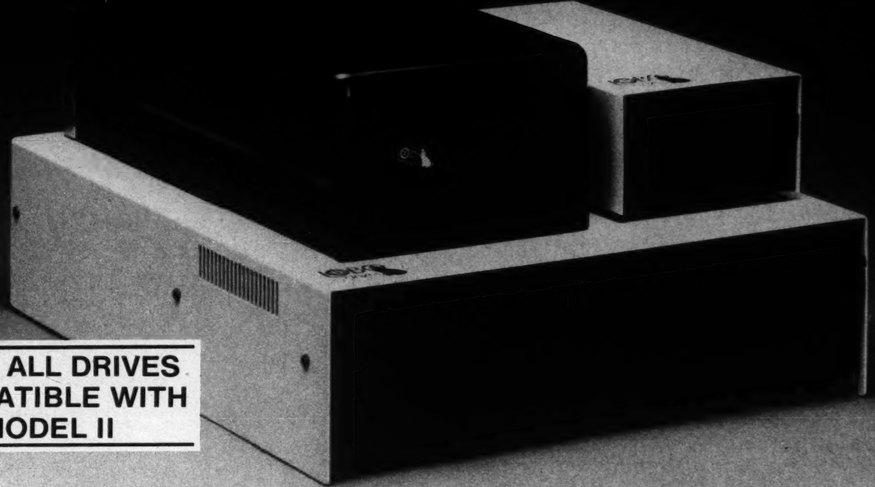

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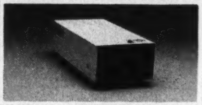

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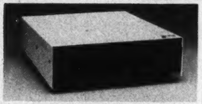

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CIRCLE 167 ON READER SERVICE CARD

I/O, cont'd...

reflection of the quality of the writer's thoughts.

Now, no one expects great literature, but this is quite below your standard. Mr. Yob, to take an example, writes with concision; perhaps because he always has something new and useful to say. By contrast, Mr. Lindsay finds it necessary to inform us that the Atari computer "plugs into an ordinary wall socket." One can hardly imagine an alternative.

Richard Mansfield
R.D. 3, Box 82
Philipsburg, PA 16866

Powerful Interface

Dear Editor:

From my point of view as a professional writer with an M.A. in English Literature, the Touring Test [sic] is of extreme importance.

It makes no difference to me whether the successful completion of this test would indicate genuine machine intelligence or simply clever programming. As a matter of fact, I don't really care if a machine could ever pass such a scrupulous laboratory test.

What interests me is the power of such a model of machine-human interface, as demonstrated by the irresitible draw that the "Eliza" program exerts on so many. This program can be seen as an early example of a new genre of art, *interactive literature*.

Such a literature doesn't have to have a complete one-to-one relationship to the reality it depicts. It doesn't have to be air tight and completely convincing. All art supposes a willing suspension of disbelief. Most people who see *Star Wars* don't really believe in the existence of that particular galactic empire, but allow themselves to pretend that they do. (Those few people who take *Star Wars* literally would probably also hang on Eliza's every word as advice from a real mental health professional).

I think that *Moby Dick* is one of the greatest novels ever written, yet I don't believe that such a great white whale ever existed.

"But," you may say, " 'Eliza' is based on programming tricks! It doesn't *really* answer my questions!" All writing works with the help of "hidden wires and trap doors" that you, the reader, are not supposed to notice. At least "Eliza" allows you to ask your questions, which is more than *War And Peace* ever did!

Robert Schultz
140 N. 21st
Philadelphia, PA 19103

"But 'Eliza' is a deception!" Plato says all poetry is lies.
P.S. Once I get a Basic interpreter up on my KIM-1 based system, I'll be able to give you a better idea of the direction that such a new artform must take.

We're looking forward to it. —*Ed.*

Studebaker Mismaligned

Dear Editor:

Byte your Tongues, Sirs!

Your reference to the good name of Studebaker in a derogatory manner in your December issue cannot go unchallenged!

For your information, Studebaker cars did not vanish from the market for lack of quality or buyer support. At the time, Studebaker had become a conglomerate with manufacturing activities in other fields which were more profitable and it was the decision of management to terminate (!) production for that reason.

It should be noted that in the early 30's, the name Studebaker stood for quality, speed and practically complete customer loyalty. It was during that period that Studebaker held all of the AAA records for speed and endurance and maintained a standard of precision manufacture that led a Rolls Royce official to remark, after he had toured the plant, that Studebaker precision and quality control was higher than theirs!

Presently there are thousands of satisfied Studebaker drivers who have no problem getting parts at prices well below that of the current offerings of other makes, and several clubs, with an aggregate membership of perhaps 20,000 members, are exhibiting growth. New parts for the later models are still being produced to take care of the demand both here in the USA and in foreign countries where many Studebakers are still serving faithfully as taxis, personal transportation and, in many cases, industrial power sources.

The original corporation, still very much alive, has recently been absorbed by McGraw Edison and the name is being kept alive.

It may also be interesting to note that I have a Studebaker truck that is 20 years old but still tough enough to pull a tractor buried in a creek bed not long ago, so any reference to Studebaker should credit them with honor, precision and longevity!

Bob Forman
P.O. Box 68
Monmouth, IL 61462

Sum Problem Solution

Dear Editor,

I am enclosing a computer solution to the "sum problem" on page 172 of the May 1980 Creative Computing. I wrote the program on a Level II TRS-80. It takes the computer about 5 seconds to find the correct solution and about 25 seconds more looking for other solutions. I thought this problem was particularly interesting because it demonstrates a problem that cannot be solved mathematically, but can be solved with a computer.

```
5 CLS : PRINT "SOLUTION TO THE 'SUM PROBLEM' - AB * C = DE WHERE A+B+C+D+E = 27"
10 FOR A=1 TO 9
20   FOR B=0 TO 9
25    IF A=B GOTO 100
30     FOR C=1 TO 9
35      IF B=C GOTO 90
40       AB=10*A+B
50       DE=AB*C
55       IF DE>99 GOTO 90
60       D=INT(DE/10) : E=DE-D*10
65       IF D=A OR D=B OR D=C OR D=E GOTO 90
70       IF E=A OR E=B OR E=C GOTO 90
80       IF A+B+C+D+E=27 PRINT "THE SOLUTION IS : A =";A;" B =";B        ;" C
 =";C;" D =";D;" E =";E
90      NEXT C
100   NEXT B
110 NEXT A
120 END
```

Gary A.Schoon
4530 Debonair Circle
Colorado Springs, CO 80917

Experiment In Relativity

Dear Editor:

I greatly enjoyed your April Fool magazine parody. The "world's largest floppy disk drive" was especially interesting. It might interest you to know that a disk rotating rapidly enough for its edge velocity to approach the speed of light is a classic "thought experiment" in Relativity. In the simple case of linear motion relative to an observer, an

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CIRCLE 154 ON READER SERVICE CARD

I/O, cont'd...

object moving at a high fraction of light speed will be foreshortened in the direction of its motion. In the case of a rotating disk, an observer at the center will see objects on the disk moving faster and faster as their distance from the center increases. The foreshortening will now be tangent to the circle of motion, and will increase as the radius increases. As a result, the surface area of the disk will be greater than pi times the square of the radius. The length of each track will be increased by the reciprocal of the foreshortening, and the foreshortening will increase with the radius. Towards the edge, tracks could be light-years in length but still have their original radius. The only practical problem would be preventing centrifugal force from flinging the bits off the disk.

Kimball M. Rudeen
57 Taft Ave.
Lexington, MA 02173

Graphics Digital Clock Debugged

Dear Editor:

I was surprised to see in the April '80 Input/Output column that Mr. Sullivan found a "bug" in my "Graphics Digital Clock" program (October 1979, p. 110).

In checking out my copy again, I was unable to duplicate the error that Mr. Sullivan found, even after running it through several complete cycles in both 12-hr. and 24-hr. formats.

One possible explanation of this discrepancy is simple miskeying: When a 5 x 7 dot-matrix listing must be reduced in size for publication, it is easy to misread some critical characters, such as the "D1" in line number 370.

Also, the TRS-80 Level II Basic will sometimes give a false "NEXT without FOR" error signal. To see this, try the following little demonstration program:

```
10 FOR I=1 TO 20            60       NEXT I
20    IF I=10 GOTO 40       70    NEXT J
30    NEXT I                80 PRINT "OK"
40 FOR J=1 TO 20            90 END
50    FOR I=1 TO 20
```

I was not aware of this potential problem when I wrote the program. If I had been, I probably would have changed line 350 to read:

```
350   IF D1=C AND D2=D THEN D2=9
```

(change underlined)

If I try to RUN this, I get: ?Nf ERROR IN 70. The problem comes from reusing an index variable after exiting from a FOR loop before normal completion. If I change the index in lines 50 and 60 from "I" to "K," it will run all right. The Radio Shack Computer Services Center in Fort Worth suggests resetting the index to zero before reusing it (even though the FOR should reset the index).

This simple change should avoid any problem. As I said, the program runs all right on my TRS-80 as published. It seems that there are slight differences in the ROMs of some TRS-80s so some users may have to make the change shown above. I would appreciate hearing from anyone else who has had a similar problem.

Delmer D. Hinrichs
2116 S.E. 377th Ave.
Washougal, WA 98671

Order of Royalty

Dear Editor:

In reference to the article "DUKEDOM" (*Creative* Feb 80): Mr. Kaapke writes in his Historical Waiver that "A Duke would have as his lord not a king but a Count or an Earl and would have under him Barons or Marquises." This is incorrect. The position of Duke is preminent in the five orders of nobility. In history one immediately thinks of William the Conqueror, Duke of Normandy, King of England; and the Duke of Burgundy who rivalled Louis VII at the time of Joan of Arc, for control of France. In more recent times we have Edward, Prince of Wales, who abdicated from the British throne and was Duke of Windsor. Prince Philip is currently Duke of Edinburgh.

The five ranks of peerage in order, are: Duke, Marquis, Earl (or Count), Viscount and Baron. This follows roughly upon the Continent as well.

Peter Fellows
108 Clearview Ave.
Ottawa, Ontario
Canada

Painful Language

Dear Editor:

In Strunk's* name, why do you bother to run articles on style and effective writing when you still insist on using the monstrous construct HE/SHE, HIM/HER, HIS/HERS?

This odious affectation needs to be thrown out with the lawyer's AND/OR, the engineer's THREE (3), and most everything written by the Federal Government.

The injury to the language is more painful than any alleged fair-play benefits. If you must, use HE throughout on even months; SHE on odd.

Michael D. Zorn
360 Carriage Dr., D
Santa Ana, CA 92707

*William Strunk, *Elements of Style*

Level I Double Width Characters

Dear Editor:

I have a simple method for producing wide characters on a TRS-80 Level I. Here is a sample program:

```
10 IN." HHEELLLLOO!!
20 GOTO 10
```

(Note that a space must follow the quotation mark; there is no second quotation mark.) When run, the program first fills the screen with "HHEELLLLOO!!" Soon, the screen will freeze and change to "H E L L O !" in wide characters. One side effect is that this hangs the computer, so you must first press the RESET button before you can re-run the program.

Happy Hardware!

Ross Dexter Knights
5153 Echo Road
Bloomfield Hills, MI 48013

Gene Modifications

Dear Editor:

James Garson's program *Gene: A Genealogy Program* is well conceived and—when properly debugged—enjoyable to use.

As written, however, the program refuses to allow modifications to Name or Sex characteristics and it does not provide a complete list of descendants.

I believe the following changes will correct these problems:

(1) Delete line 732
(2) Correct line 720 to read 720 C1=0
(3) Insert a new line 625 K=W

Eliakim Willner
1510 East 4th Street
Brooklyn, NY 11230

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— Gary Montante, Ygnacio Valley HS, Walnut Creek, Calif.

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SOFTWARE PROFILE

Super-Text vs. EasyWriter

Voyle A. Glover

Here is a review of two word processors. The opinions and unusual tastes expressed are those of the author.

Word processing for the Apple has been sadly lacking until recently. Now, with Super-Text and EasyWriter there is no longer a need for writers or would-be writers to work in frustration at a typewriter while several thousands of dollars worth of computing equipment sits idle, simply because there was no word-processing software available. Oh, there has been software, but, personally, I would hesitate to call it word-processing software. There were just too many limitations in the products.

Super-Text is put out by Muse Software, 330 N. Charles Street, Baltimore, MD 21201, and sells for $99.95. It is a superb product written by Ed Zaron. EasyWriter is offered by Information Unlimited Software, 793 Vincente, Berkeley, CA 94707, and also sells for a few pennies under $100.00. It was written in Forth by a savvy gentleman by the name of John Draper. (*Formerly known internationally for his exploits as a phone freak, Cap'n Crunch Draper has gone straight under the new identity of Cap'n Software.—Ed.*)

Neither program is compatible with Apple DOS, but this is no problem. They run fast and are very efficient. Super-Text offers more utility than EasyWriter, but the latter, in my opinion, offers more future potential. If Cap'n Software incorporates the changes suggested by this writer and others, it will be in a class by itself. However, until they make those changes, I have to rate it about even with Super-Text. I like both of these programs for different reasons and if I did not have both, I would definitely get both.

** Rating Table **

(scale: 1 to 10)	EZ	ST
a) versatility	7	10
b) utility	7	10
c) ease of use	10	8
d) documentation	8	6
e) disc system	10	9
f) speed	10	8
g) special features	7	9
h) printer routine	8	9
i) mastering system	10	6
j) editing system	10	8
(sub totals)	87	83
	(Negatives)	
(scale: 0 to -5)		
1. auto-paragraph	-5	0
2. pagination	-5	-1
3. titling	0	-5
4. program recovery	0	-5
5. underlining	-5	0
Total Rating :	72	72

There are other minor things I could have rated negatively, but these items were included in the overall ratings and thus were not placed here. Only those items that were difficult to fit into the rating, yet were separately important, were included in the negatives. I did not, for instance, list file merging as negative because this was one of the items calculated into the rating. Thus, EasyWriter got a "7" both in "special features" and "utility," partly because they do not have this feature.

Super-Text got low marks in documentation for an unattractive and poorly-written manual.

Super-Text

Super-Text offers many special features, but perhaps the best thing it offers (for this writer, anyway) is superscripting, subscripting, underlining and boldface. (While EasyWriter does offer the sub- and superscripting [which was left out of the old manual], they do not offer underlining in a practical fashion. It takes lots of patience to underline with EasyWriter.) Super-Text (version 2.0) also has upper- and lower-case capability and is designed to run with the Dan Paymar board [see below]. Super-Text also allows use of the Applesoft board (switch must be "up"). This new version also permits loading of all on-line files: you can load a file from either disk drive.

[Note: This is a plug-in unit which enhances the Apple's normal character generator with lower case and does not require an accessory slot. It is $49.95 from Dan Paymar, Box C-109, C.S. 6800, Costa Mesa, CA 92627.—Ed.]

Voyle A. Glover, P.O. Box 212, Griffith, IN 46419.

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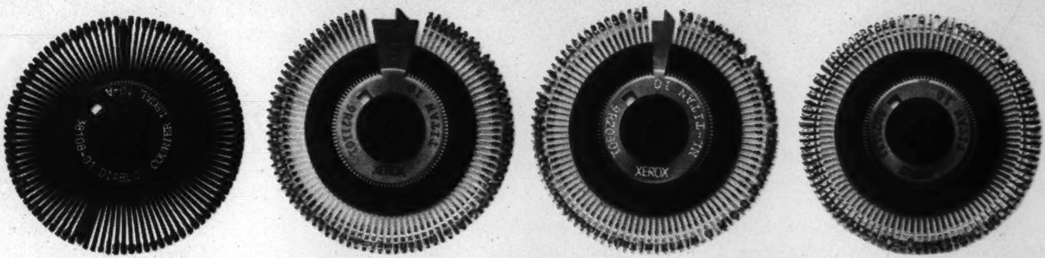

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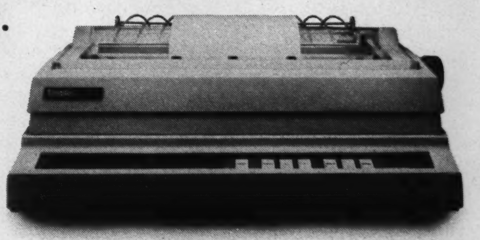

Diablo Systems

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CIRCLE 134 ON READER SERVICE CARD

Versus, cont'd...

Super-Text offers some unique features, such as a "multiple window" which allows a view of a horizontally divided screen. This allows you to make changes in a portion of your text while you have a copy of the same text below or above for reference. Thus, if you changed something and didn't like the change, you may opt to go back to the old version or jump to the other screen and make a new change there. Personally, I like the feature because I can always have the line I am typing right in the middle of the screen, instead of the bottom. It is a very useful feature.

I like both of these programs for different reasons and if I did not have both, I would definitely get both.

Super-Text has also incorporated a little something that is handy, provided you can force yourself to get into the habit of using it. You can, with one key stroke, cause the ":" character to become the word "the." Thus, each time you want "the," you simply hit ":". A nice feature, indeed. A several-key control sequence allows you to use colons, also.

I like the Autolink feature of Super-Text. Using Autolink, one can have access to all on-line files, and can even do a search and replace on every on-line file. If you wanted to replace a character's name in a novel, then using Autolink the program would call the next linked file, search it for the string or name, replace it with the string or name you indicated prior to the search and replace routine, save the updated file, load the next linked file, and so on. Definitely another plus for Super-Text.

Super-Text offers a math module with their program. This should prove to be a tremendous enticement for those businessmen who have reports, board meetings and other materials which require figures incorporated into the text. Using Super-Text, a secretary can type the report, type in the figures, and have all the math done (and check the boss' totals!) by the computer. The module features columnar additions with aligned decimals as well as direct calculations. Thus, this program offers much for technical writers, accountants writing reports, secretaries given the task of making sure the boss is correct, and businesspersons doing a financial position analysis (for a bank loan, personal records, etc.).

Super-Text offers file merging, another nice feature. This can be of particular use when you want to insert tables, or perhaps contractual language or footnotes, into a text. There is also a very useful block copy, save or delete system that works with this. Using the block mode, one can separate a paragraph using special characters (Ctrl V), and then either save that section to disk, insert it into text elsewhere, delete the block only from your text, or delete the block markers.

EasyWriter

The important thing to remember about the EasyWriter program is that *it is easy*. There is just no comparison between EasyWriter and Super-Text when it comes to ease of operation. If ever a program deserved the name it has, this one does. In addition to being super-easy, this program is fast. I have never overtyped EasyWriter; that is, I have never been able to type so fast that I lost a character on a wraparound (where a word too large for the current line is automatically dropped to the next). This did happen with Super-Text, although there is a way to avoid this (by using the split screen and typing in the center at all times). EasyWriter saves fast, edits fast, loads fast; in every respect but one, it is a very fast, smooth program.

That one thing has to do with the commands for a partial printout of a file. If you want the first page of chapter three of your novel printed, insert ".e" at the beginning of your file, and you insert ".b" at the beginning of where you want your printout to begin. Then, another ".e" after that section of text will end printout. This all works well, but the problem is that the program processes everything. Thus, if you have a lot of text ahead of the part you want printed, you will sit idle for some time, waiting just as long as if you were getting an actual printout.

EasyWriter has a feature which makes it really shine for me, and it is one all klutzes (like me) will appreciate. With little fuss, you can make a master backup disk. This can even be done with only one disk drive, and the backup master will contain the complete EasyWriter program except for the logo. It is a comforting feeling to know you can have all the backup copies you need. (Of course, the problem here is those friendly thieves who make a copy for a buddy. I hope that kind of person does not force EasyWriter to change this.) Data disks can be made at the same time, and again, "easy" must be emphasized. No parameters to put in, no "bloads" and "bruns" and "bsaves." Just a simple "y" or "n."

Proportional spacing is a very desirable feature of EasyWriter. Many printers now have this capability; if you've a printer which allows this feature, then EasyWriter is just the ticket. Using proportional spacing, there are no unseemly gaps in your printed text and all the text is neat and professional-looking.

Provided you can force yourself to get into the habit of using it, you can, with one key stroke, cause the ":" character to become the word "the."

Unlike Super-Text, EasyWriter has an integrated edit/format system. This means that if you are typing merrily along and discover the need to make some revisions in an earlier part, there is no special mode or system you have to enter. You simply move the cursor to wherever you need it with a scroll or search command, and do what you need to do. Once more, the emphasis is *easy*. It is a simple job (and extremely fast) to move text around, edit, delete, and leap back to where you left off. One feature I especially like is the way that EasyWriter allows you to open up your text. A Ctrl G will insure that any "returns" you do will cause the text to split. This allows you to insert material very easily. (Super-Text also permits this kind of insertion, but it is not as easy or as versatile.) And when you are done, EasyWriter will automatically close up any gaps in your text, whether they are line gaps or spaces between words.

Going from the print system to the disk or the edit system is also very easy. If you have just printed your text out, then a simple "D" will put you into the disk system. There, you will be shown a list of commands, each explained but represented by one letter. Thus, a "G" would get a file and load it into memory, while an "S" would save whatever text was in memory under a name you specify. (However, as with Super-Text, when you ask for that file in the future,

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CIRCLE 220 ON READER SERVICE CARD

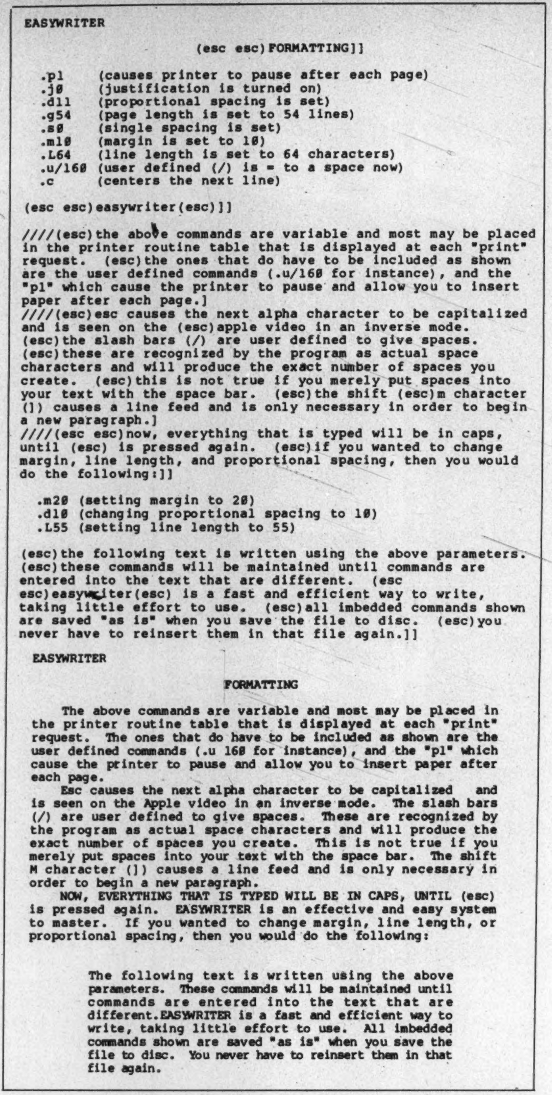
Versus, cont'd...

although the name is displayed, you can use the number—much easier.) Then you can, with a one-letter command, go back to the editor or to the print system.

EasyWriter has something else that is fantastic for klutzes. It has the ability to let you hit Reset and not lose a thing! I've had many occasions when I've goofed (you never do, right?), and gotten it all back together with a hit on the Reset button. (Not so with Super-Text. Perhaps someone who knows more about his Apple and about the monitor system would have had no problems, but I put in about six hours worth of typing using Super-Text when, in my best klutz technique, I tried to save the work to a data disk while the little door was open on my drive. I tried everything I knew, referenced the Super-Text manual, magazines, and Apple manuals, all in vain; I just could not recover.) So, if you've a bit of a problem shifting mental gears at times, EasyWriter could be what you need.

There is just no comparison between EasyWriter and Super-Text when it comes to ease of operation. If ever a program deserved the name it has, this one does.

Finally, EasyWriter has a user-defined keystroke delimit capability that is exceptionally easy to use. The only fault with it is that you can only have one at a time. (This, according to Mr. Larry Weiss, of EasyWriter, will be corrected "in the near future.") If you wanted, for instance, to have spaces every time you hit the slash, you may easily do it with the command ".v/160".



```
EASYWRITER

                    (esc esc)FORMATTING]]

   .pl    (causes printer to pause after each page)
   .j0    (justification is turned on)
   .d11   (proportional spacing is set)
   .g54   (page length is set to 54 lines)
   .s0    (single spacing is set)
   .m10   (margin is set to 10)
   .L64   (line length is set to 64 characters)
   .u/160 (user defined (/) is = to a space now)
   .c     (centers the next line)

(esc esc)easywriter(esc)]]

////(esc)the above commands are variable and most may be placed
in the printer routine table that is displayed at each "print"
request.  (esc)the ones that do have to be included as shown
are the user defined commands (.u/160 for instance), and the
"pl" which cause the printer to pause and allow you to insert
paper after each page.]
////(esc)esc causes the next alpha character to be capitalized
and is seen on the (esc)apple video in an inverse mode.
(esc)the slash bars (/) are user defined to give spaces.
(esc)these are recognized by the program as actual space
characters and will produce the exact number of spaces you
create.  (esc)this is not true if you merely put spaces into
your text with the space bar.  (esc)the shift (esc)m character
(]) causes a line feed and is only necessary in order to begin
a new paragraph.]
////(esc esc)now, everything that is typed will be in caps,
until (esc) is pressed again.  (esc)if you wanted to change
margin, line length, and proportional spacing, then you would
do the following:]]

   .m20 (setting margin to 20)
   .d10 (changing proportional spacing to 10)
   .L55 (setting line length to 55)

(esc)the following text is written using the above parameters.
(esc)these commands will be maintained until commands are
entered into the text that are different.  (esc
esc)easywriter(esc) is a fast and efficient way to write,
taking little effort to use.  (esc)all imbedded commands shown
are saved "as is" when you save the file to disc.  (esc)you
never have to reinsert them in that file again.]]

  EASYWRITER

                          FORMATTING

      The above commands are variable and most may be placed in
  the printer routine table that is displayed at each "print"
  request.  The ones that do have to be included as shown are the
  user defined commands (.u 160 for instance), and the "pl" which
  cause the printer to pause and allow you to insert paper after
  each page.
      Esc causes the next alpha character to be capitalized   and
  is seen on the Apple video in an inverse mode.  The slash bars
  (/) are user defined to give spaces.  These are recognized by
  the program as actual space characters and will produce the
  exact number of spaces you create.  This is not true if you
  merely put spaces into your text with the space bar.  The shift
  M character (]) causes a line feed and is only necessary in
  order to begin a new paragraph.
      NOW, EVERYTHING THAT IS TYPED WILL BE IN CAPS, UNTIL (esc)
  is pressed again.  EASYWRITER is an effective and easy system
  to master.  If you wanted to change margin, line length, or
  proportional spacing, then you would do the following:


          The following text is written using the above
          parameters.  These commands will be maintained until
          commands are entered into the text that are
          different.EASYWRITER is a fast and efficient way to
          write, taking little effort to use.  All imbedded
          commands shown are saved "as is" when you save the
          file to disc.  You never have to reinsert them in that
          file again.
```

Problems And Complaints

I have several complaints about both systems, and must bring out some problems I have encountered. One, rather vexing to me as a writer, is the fact that EasyWriter has a titling feature which works just about the way I need it to work, but has a page-numbering system that is absolutely worthless. Super-Text comes along with a page-numbering system (even relative numbering for chapters) that is absolutely perfect, versatile, and all one would ever need, but has zilch for the page titling. Anyone who does any amount of writing knows that on most manuscripts you are required to put some kind of title on each and every page, or at least the author's name. Both EasyWriter and Super-Text need to correct this problem.

Super-Text should rewrite their manual. It is not as clear as it should be, and definitely could use a condensation with amplification. In other words, they need to remove the repetitive material, insert more examples, and try to imagine some worst cases in user experience. I would also urge them to use a Qume or Diablo (or something similar) on which to write their manual. Dot matrix, in spite of its wide applications, is not really suited for textual material. It looks hokey and cheapens what is otherwise a quality item. It's like giving a loved one a nice birthday gift in a paper bag. It'll get you by, but that's all.

I would also like to see Super-Text come out with proportional spacing. It would compliment their fine product and add immensely to its worth. Also, they might fix a small problem with their page numbering system. It seems that on short pages (as at the end of a chapter), you will not get a page number—consequently the next page number will be wrong. I do have to compliment Mr. Zaron, however, on the excellent justification routine he has incorporated into Super-Text; I have not had a gapping problem with it. However, if you turn EasyWriter's proportional spacing off and just evaluate the two on their ability to produce excellent justified copy, then Super-Text is definitely best. I have run the same text and gotten a gap or two with EasyWriter where none appeared in Super-Text. (Both programs gap some without proportional spacing, but Super-Text does keep it to a minimum.)

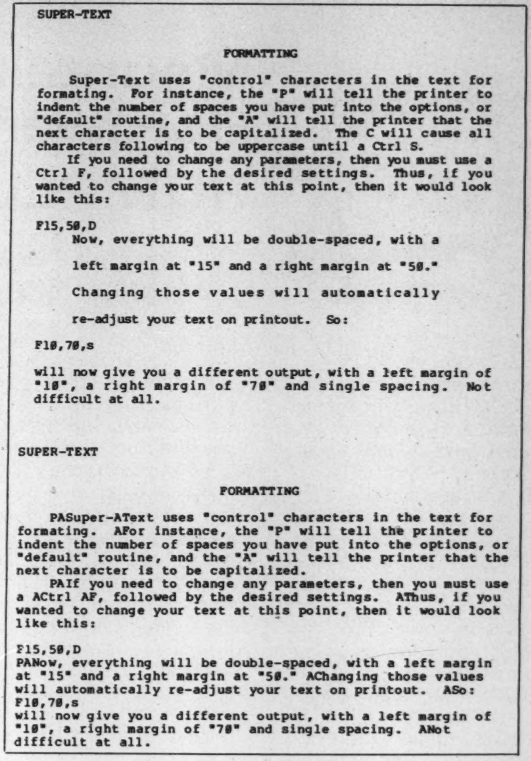
EasyWriter needs to make easier the underlining, subscripting and superscripting, and while they're at it, combine these features with proportional spacing. They also need to get rid of the shoddy ".e" and ".b" routine or at least speed it up considerably.

EasyWriter has a titling feature which works just about the way I need it to work. Super-Text comes along with a page-numbering system (even relative numbering for chapters) that is absolutely perfect, versatile, and all one would ever need.

Although EasyWriter has automatic paragraphing, it really is not practical for most applications. Presently, when you give two line returns (Shift M's), you will get an automatic paragraph sequence on the printer. However, it then doubles the space between paragraphs; a double-spaced manuscript would have four lines between paragraphs! Thus, a single-spaced letter or text would have two lines between paragraphs. The easy way around this is to define the "slash bar" (/) as a space. Then when you reach the end of a paragraph, do a shift "M," a "Return," then hit four or five slash bars and begin your new paragraph.

Finally, I have some suggestions for updates that would really make both of these products even more attractive. First, I think they ought to include the ability to utilize bi-directional printing. Many of us have a printer with that capability. We need software that will allow it. The EasyWriter people have informed me that this feature will be incorporated into their "Easy-Mailer" printer routine, but not EasyWriter itself.

Another useful feature would be something along the order of the WordStar system's "end of the page" finder. That system draws a dotted line on the screen at a page break. Thus, one could know exactly where to insert footnotes without having a printout.



```
SUPER-TEXT


                         FORMATTING

     Super-Text uses "control" characters in the text for
formating.  For instance, the "P" will tell the printer to
indent the number of spaces you have put into the options, or
"default" routine, and the "A" will tell the printer that the
next character is to be capitalized.  The C will cause all
characters following to be uppercase until a Ctrl S.
     If you need to change any parameters, then you must use a
Ctrl F, followed by the desired settings.  Thus, if you
wanted to change your text at this point, then it would look
like this:

F15,50,D
     Now, everything will be double-spaced, with a

     left margin at "15" and a right margin at "50."

     Changing those values will automatically

     re-adjust your text on printout.  So:

F10,70,s

will now give you a different output, with a left margin of
"10", a right margin of "70" and single spacing.  Not
difficult at all.


SUPER-TEXT


                         FORMATTING

     PASuper-AText uses "control" characters in the text for
formating.  AFor instance, the "P" will tell the printer to
indent the number of spaces you have put into the options, or
"default" routine, and the "A" will tell the printer that the
next character is to be capitalized.
     PAIf you need to change any parameters, then you must use
a ACtrl AF, followed by the desired settings.  AThus, if you
wanted to change your text at this point, then it would look
like this:

F15,50,D
PANow, everything will be double-spaced, with a left margin
at "15" and a right margin at "50." AChanging those values
will automatically re-adjust your text on printout.  ASo:
F10,70,s
will now give you a different output, with a left margin of
"10", a right margin of "70" and single spacing.  ANot
difficult at all.
```

Something else that both need is a flexible titling and pagination system. There are as many different formats for manuscripts as there are different kinds of writing, and flexibility is a must.

Future Developments

Muse is coming out with an 80-column update of Super-Text utilizing the new 80-column, upper/lower case board. I have no dates, but I would presume that this update is now available or will be soon. Also, I am sure that Muse will remain competitive and innovative, bringing out updates and neat features. They seem to be that kind of company. (Anyone who can give an automatic "the" is "thinking" in my "direction.") Who knows, perhaps they will incorporate some of the suggestions in this review.

Easy Writer seems to have made the complete jump to a professional system—at least, that's what they've named it. It utilizes the 80-column board (you must have a monitor) and offers just about everything a word processor should. This new system, I'm told, will give you a "what you see is what you get" visual—on screen justification and suppression of control characters. Everything will look, on screen, exactly as it will on paper. I understand the entire system, including the board, will go for something around $500. It will give bi-directional printing, five user-defined characters at once, and file merging. Mr. Weiss informed me that they do, however, intend to update the present EasyWriter to almost all of the specifications of the new system except the 80 columns.

EasyWriter has something else that is fantastic for klutzes. It has the ability to let you hit Reset and not lose a thing!

Anyway, it seems that word processing has come to the Apple at last, and that we can take the worms out. As these manufacturers compete for our business, I have no doubt they will improve their product. We can only benefit. Meanwhile, I highly recommend both the EasyWriter and the Super-Text word processors.

As for the great question that is bothering all of you—"Which program did he use to write this review?"—I have to leave you with this: Only my editor knows for sure... ☐

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EQUIPMENT
PROFILE

Mountain Hardware ROMPLUS +

Steve North

Mountain Hardware's ROMPLUS+ board is an EPROM memory board for the Apple II with a capacity of 12K bytes. The board also has 255 bytes of on-board scratchpad RAM and two TTL inputs for user applications. The ROMPLUS+ also has an onboard control ROM that allows the other ROM software to be accessed easily via ordinary input and output commands.

All this is very nice, but not especially useful unless you're going to develop your own ROM-based software. However, Mountain Hardware also has an optional plug-in ROM for the ROMPLUS+ board, the Keyboard Filter, which takes advantage of this hardware to expand the I/O features of the Apple.

The Keyboard Filter generally interacts with the user and the other system software much more gracefully than other packages.

Like the other character generators we previously reviewed for the Apple, the Keyboard Filter draws software-defined character fonts on the high resolution graphics screen of the Apple to provide upper and lower case characters or anything else that can be drawn in a 7x9 dot matrix. The Keyboard Filter has some other interesting features which the other character generators do not, though, and it generally interacts with the user and the other system software much more gracefully than other packages. For example, the Keyboard Filter software can be activated by typing PR#5 (to get the attention of the control ROM) and then control-shift-M 1 (to turn on the Keyboard Filter installed in ROM socket 1). This is easier than loading a program stored on cassette or disk and also eliminates some fussing around to avoid memory collisions with other programs.

The Keyboard Filter processes input and output by intercepting and processing characters like any other I/O device (such as a disk or printer). Most of its special functions are accessed by outputting control characters, either by PRINT statements or echoing them from the keyboard. The functions include selection of character fonts, colored and inverse video text, cursor movement, overstrike and "keyboard macros" (single-stroke shorthand entry of longer character sequences).

One of the TTL inputs on the ROMPLUS+ may be connected to the shift key on the Apple so that it can operate with some semblance to a normal typewriter keyboard. Since the Apple keyboard is normally upper-case only, the alternative is to define some particular control character to mean "toggle upper/lower case." It's much more people-oriented to type with the shift key. So, by looking at the status of the shift key the Keyboard Filter software can determine if the user is entering upper or lower case. Unfortunately, the Apple keyboard has the exponent and at-sign over the N and P keys respectively, so to type these symbols, if you've made the shift-key modification, you have to type a control character to toggle into "raw mode" to enter the symbol, and then type the control character again to get back into normal upper/lower case. Since these two symbols are not entered frequently, it's a very reasonable tradeoff to make.

The documentation for the hardware and software was better than average. It will provide the casual user with enough information to access the Keyboard Filter from Basic, and if you're interested in machine language programming or making your own ROMs, there's also enough documentation of low-level bit diddling. The ROMPLUS+/Keyboard Filter behaved nicely with Integer and Applesoft Basic in ROM and also talks with Applesoft in RAM. However, it cannot be activated at the same time as other peripherals that overlap the address space at C800-CFFF (such as the D.C. Hayes Micromodem).

The quality of the hardware and software is what we've come to expect from Mountain Hardware. It's sophisticated, flexible, and easy to use. However, before buying one, consider that the software you write with embedded Keyboard Filter commands may not be very transportable to other Apples without this add-on. Also, it's a bit on the expensive side since you can get software character generators for about $20 (although they are not as powerful or convenient, and don't have the shift-key modification). Still, for designing your own custom software or funny little programs in Basic, we recommend the ROMPLUS+/Keyboard Filter if you can justify the price.

The quality of the hardware and software is what we've come to expect from Mountain Hardware.

The ROMPLUS+ with Keyboard Filter is available for $200.00 from Mountain Hardware, Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060. (408) 429-8600. ☐

Keyboard Filter Control Codes

A	No function
B	No function
C	Normal function — stops programs
D	Normal function — DOS commands
E	Turns on cursor movement mode
F	Font switching — followed by number of desired font
G	Normal function — bell
H	Normal function — backspace
I	Toggle inverse mode
J	No function
K	Select input from peripheral — followed by slot number
L	Toggle shift lock
M	Normal function — carriage return
N	No function
O	Toggle overstrike mode
P	Switch page being displayed
Q	Select output to peripheral — followed by slot number
R	Toggles raw mode
S	Prints keyboard macro — followed with key for desired macro
T	Selects color — followed by number of desired color
U	No function
V	Toggles shift key usage in modified Apples
W	Copy to end of line (for editing)
X	Normal function — delete line
Y	No function
Z	Clears current page

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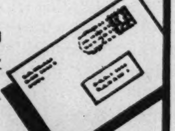

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SOFTWARE PROFILE

Dynamic Domino

The Basic Programmer's Toolkit

Donald Goodman

Sandra Schwab

The PET computer can be compared with the Volkswagen Beetle of old — small, simple to operate, cheap enough for almost any budget, yet large enough to do many basic jobs well. However, the PET has a few primitive operations which make it less than a perfect instrument. It requires the operator to assign line numbers one at a time, by hand at that. If additional statements are needed within a program the re-numbering process is one which is ideal for creating torpor or ennui. Moreover, while the operator is punching out new numbers and counting "one-hundred-ten, one-hundred-twenty, one-hundred-thirty" like a Zen meditator counting out his exhalations, another part of his mind must remain alert for GOTO, GOSUB and similar detour signs which must be hand-altered along the way. If an entire section of a program needs to be deleted the operator must wipe it out one line at a time, another repetitive, half-a-brain process.

Discovering where an error has been made can be a frustrating, step-at-a-time search on a PET. It sits there saying ?SYNTAX ERROR, with the implied "SEARCH ME," when the operator asks "Where is the error?"

These and similar PET hand-cranked procedures caught the attention of Harry Saal, a veteran in the field of personal computers. Mr. Saal, in his Nestar Systems, Inc., has manufactured a Basic Programmer's Toolkit for use on the PET. Actually, the device shouldn't be called a Toolkit. It's more like an automatic transmission.

Installing the Toolkit

PETs, like bears, come in three sizes: 8K, 16K, and 32K. While we had several 8K PETs in use at Muskegon Community College, we requested one of the 32K Toolkits to fit into the new PETs we had on order. Our Toolkit was a single chip — a piece of black plastic about an inch and a quarter long and half an inch wide, as thick as two sticks of gum. Call it a miniature domino. The instruction manual accompanying the chip gives very clear directions and simple drawings telling what to do and what not to do. Our Toolkit prongs did not quite line up with the Computer ROM and had to be bent to fit. This is a minor problem but the prongs should not be bent much, or often. The installation process on the "new" PETs is about as complicated as changing a headlight on your car.

The search mechanism looks for balanced lines and logical statements. It will point out an unbalanced line but may, on occasion, suggest an erroneous solution.

"Old" PETs can be equipped with a Toolkit which mounts on the memory expansion and the second cassette ports. The ability to expand the memory would then be nullified. There is also a Toolkit for older PET models which can be connected to Expandaman or Skyles memory expansion units.

Turning it on

To activate the Toolkit, the programmer keys in "SYS 49056" and presses the RETURN key. A response of (C) 1979 PAICS indicates that the Toolkit is functioning. The command must be given each time the computer is turned on. Otherwise, the Toolkit will be ignored by the PET. However, the command can be keyed in anytime during a program, whenever the Toolkit's functions are called for.

Function: AUTO

(Key: AUTO)

Keying "AUTO" gives the program automatic line numbers. The Toolkit, unless directed otherwise, begins with line 100 and assigns lines in increments of 10. An operator may, of course, begin assigning lines at any number, and may use any increment. If a different interval is chosen, and if the program is interrupted (for instance, to correct an error) the Toolkit will remember the last number it presented, and will continue to present line numbers at the previously chosen interval, as long as AUTO is typed in again.

There were no problems with the AUTO function.

Function: RENUMBER

(Key: "RENUMBER" and first line number and interval desired.)

RENUMBERING gives the operator the ability to renumber a program in order to insert additional statements. For instance, suppose a program is being typed having the automatic 10 line intervals, 100 beginning line. The programmer discovers the need to insert 25 additional statements between lines 120 and 130. Without the Toolkit the operator has a long job ahead. The Toolkit, however, permits him to command: "RENUMBER 100, 25." The necessary space is thus created between 120 and 130. The command also, of course, gives 25 line intervals between all the other entered lines. The first line would still be 100; the second line would change from 110 to 125; the third line would change from 120 to 150.

Donald Goodman, Sandra Schwab, Muskegon Community College, Muskegon, MI 49442.

Toolkit, cont'd...

Renumbering will also change all previously entered GOTO, GOSUB, IF-THEN, ON-GOTO, and ON-GOSUB statements. This is a genuine time and brain-saver. GO-Hunting is one of the least productive and most frustrating of operator activities.

Caution with RENUMBERING

The RENUMBER command covers the entire program. If an operator has reserved, say, lines 300 to 400 for certain information, and, after typing line 900, decides to insert additional information between 850 and 860, a command to RENUMBER *will give all lines a new number.* The lines 300 to 400 may no longer be restricted to the information previously contained.

Function: DELETE

In an out-of-the-carton PET, if mistakes are discovered after typing, or if a program is under revision and entire lines need to be deleted, each incorrect line must be removed individually. The Toolkit allows the operator to delete as many consecutive lines as desired by using one command: DELETE 100-500, for instance. This action is similar to the PET's LIST command.

Caution with DELETE

If an operator wished to delete section 380-500 but typed only DELETE 380-, everything after 380 would be deleted. As with any massive command, this one has potential for a massive mistake in the hands of a day-dreaming operator.

Function: HELP

When the screen signals an error in a certain line, the command HELP will reprint that line, highlighting the error in reverse field. If the screen indicates a syntax error, then typing HELP will deliver the faulty line and, in many cases, will point out the error.

Caution with HELP

The search mechanism looks for balanced lines and logical statements. It will point out an unbalanced line but may, on occasion, suggest an erroneous solution. For instance, an extra entering parenthesis typed on a line will bring forth a suggestion that an additional final parenthesis ought to be added, rather than that the first one ought to be removed.

The error-marking cursor will usually stop at the last character which is acceptable to the computer. This may be before the actual error.

The HELP function was found to be one of the most useful operations in the Toolkit when trying to debug a program. It might well be worth the price of the Toolkit all by itself.

Function: TRACE

TRACE is used for debugging. It is a rapid STEP procedure. Too rapid, in fact. The TRACE command sets into motion a trace that runs at the same time the program runs. The last six statement lines being TRACED appear in a small window in the upper-right-hand corner of the screen. The numbers appear very rapidly. They can be slowed by pressing the SHIFT key, but even the slowed speed is really too fast to allow an operator to follow on a printed program listing. Moreover, stopping the TRACE stops the program. The operator finds himself continually breaking into the running program while trying to catch the TRACE at the correct spot. A command of CONT will resume the TRACE after it has been interrupted.

When making a rapid search the operator may hold the shift key down and the line numbers will proceed rapidly down through the window. When he wants to stop at any point the operator lifts his finger off the key.

Caution with TRACE

Stopping the TRACE stops the program and presents, on the screen, a BREAK-IN statement which distorts the display of the program. In addition, the display of the TRACE in the window will be considered by the computer to be part of the values that have been put in. Whatever is shown in the window blocks out other parts of the screen display which would ordinarily appear there.

Function: STEP

STEP is a slowed version of TRACE. A window in the upper right hand corner displays six lines, but it changes only one line at a time as long as the shift key is struck and not held down. When making a rapid search the operator may hold the shift key down and the line numbers will proceed rapidly down through the window. When he wants to stop at any point the operator lifts his finger off the key. The search stops and all movement in the window stops.

Caution with STEP

As with *TRACE,* the computer considers that the numbers appearing in the display are part of the program. This means that all inputting should be done *below* the window (the sixth line).

The STEP is in some ways easier to control than TRACE. It moves at a more leisurely pace, and turning it on and off requires only pressing or lifting one key. The TRACE procedure, remember, must be restarted with an additional statement each time it is interrupted.

Both STEP and TRACE can be turned off by typing the word *OFF.*

Function: DUMP

This command tells the PET to dump the extant values for all non-array variables onto the screen. It will give the programmer all the variables in the program followed by the value stored in its memory for each one.

I = 3
S = 2.4, etc.

The variables appear in the same order in which the computer executes the line numbers. GOTO statements, for instance, are followed in the dump operation as they would be in the program. Array statements will *not* be displayed during a dump operation.

During DUMP the display can be controlled by holding down the shift key. This option will be valuable in the event you have a large number of variables to be displayed. Pushing down the key interrupts the DUMP operation; releasing it allows the operation to continue.

Function: FIND

FIND is an index type of search. It activates what is known in the reading field as a scanning technique. Typing FIND, then typing whatever the operator is looking for, and then typing the inclusive line numbers, will result in a search for and a display of all lines containing the characters chosen.

If commanded, for instance, to find J, the computer would root out all J's, whether parts of words, comment statements, formulas, or what have you. However, it would pass over all J's set in quotation marks. If the operator calls for a search for "J" (note quotes) the computer will search for only those J's enclosed in quotation marks. (i.e., PRINT "JOE", or INPUT statements, or IF A $ = "JOE" THEN 20, or similar statements.)

However, the search will not recognize individual letters in key words which have been stored as

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Toolkit, cont'd...

single bytes. For instance, a FIND N command will not turn up PRINT, INPUT, END, OR THEN. Indeed, a FIND PRI command will not turn up any PRINT statements.

Function: APPEND

APPEND is used to attach a second program to the end of a previously finished program. Simply appending a program does not change the numbering of the original program. However, a command to RENUMBER will change the line numbers of *both* programs. The computer will consider the marriage to be complete, that the two are now one.

Caution with APPEND

If the original program and the appended program contain overlapping line numbers (i.e., each has a line 270) and the appended program contains a GOTO 270 statement, and the RENUMBER command is given, the renumbered program will now refer to the line in the *first* program which corresponds to the original 270.

The operator must be sure that the appended program has larger line numbers than the original program when it is written. If this is not the case, the operator would have to renumber the program to be appended and resave it onto tape or disk in its renumbered form. It could then be appended without confusion.

Summary

The Basic Programmer's Toolkit manufactured by Nestar Systems, Inc., is a simple-to-install, easy-to-master addition to the PET computer. It is a device with nine specific jobs, and it does them all very well. As long as the directions in the manual are followed, the purchaser should have no problems installing it. As long as its function and its minor foibles are understood the operator should have no problem using it.

It won't turn a PET into a wall-sized IBM, but it sure makes the little critter run smoother. And it will save on repair bills fixing up bored and babbling operators, since the Toolkit performs easily and automatically much of the drudgery formerly done by hand. That's what computers are for, isn't it?

The Basic Programmer's Toolkit is available from Nestar Systems, Inc., 430 Sherman Ave., Palo Alto, CA 94306. (415) 327-0125; for old model PET, $79.95 (Model TK-80P) and for the new PET, $49.95 (ROM only, Model TK-160).

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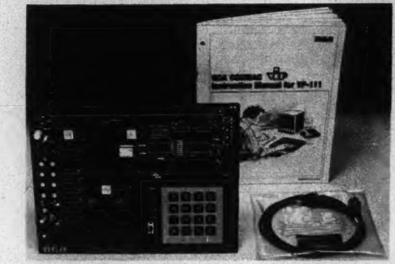

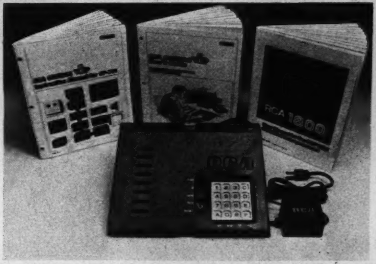

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Basics Comparison Chart

● means the feature is in this BASIC.

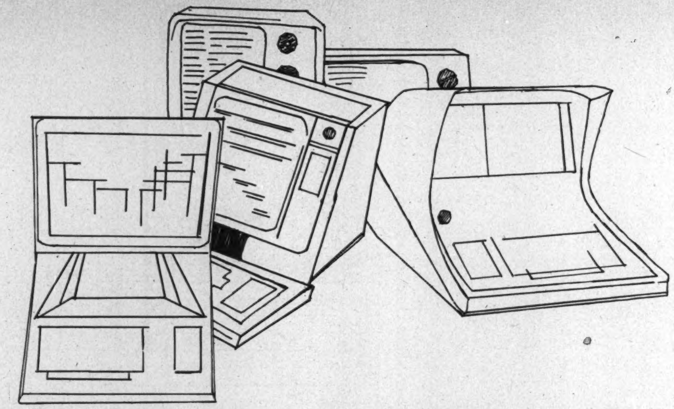
	ATARI	APPLE INTEGER	APPLESOFT	EXIDY	TRS 80 LEVEL I	TRS 80 LEVEL II	TRS 80 DOS	PET
BASICALLY BASIC								
VARIABLES								
NAMES								
Long Names	●	●						
Short Names			●	●	●	●	●	●
TYPES-NUMERIC								
Integer		●	●	●		●	●	●
Floating Point	●		●	●	●	●	●	●
Double precision						●	●	
TYPES-STRING								
DEC Style			●	●		●	●	●
HP Style	●	●						
TYPE DECLARATIONS								
DEFINT						●	●	
DEFSNG						●	●	
DEFDBL						●	●	
DEFSTR						●	●	
ARRAYS								
DIM	●	●	●	●		●	●	●
Numeric	●	●	●	●		●	●	●
String			●	●		●	●	●
INITIALIZATION								
Set to 0 or null			●	●		●	●	●
Memory trash					●			
Unknown	●	●						
ARITHMETIC								
COMPUTATION								
Binary Float point			●	●	●	●	●	●
16 bit integer		●	●	●		●	●	●
BCD Float point	●							
ASSIGNMENT								
LET	●	●	●	●	●	●	●	●
MID$ on left							●	
OPERATORS								
Arithmetic (*/+-etc)	●	●	●	●	●	●	●	●
Relational (gt, lt, etc)	●	●	●	●	●	●	●	●
Logical (AND,OR, NOT)	●	●	●	●	●	●	●	●
Boolean	●	●			●			
16 bits			●	●		●	●	●
String relational	●	●	●	●		●	●	●
Concatenation	●	●	●	●		●	●	●
FUNCTIONS								
ARITHMETIC								
ABS	●	●	●	●	●	●	●	●
EXP	●		●	●		●	●	●
FIX						●	●	
INT	●		●	●	●	●	●	●
LOG	●		●	●		●	●	●
LN	●							
MOD		●						
RND	●	●	●	●	●	●	●	●
RANDOM						●	●	
SGN	●	●	●	●		●	●	●
SQR	●		●	●		●	●	●
TRIGNOMETRIC								
DEG	●							
RAD	●							
ATN	●		●	●		●	●	●
COS	●		●	●		●	●	●
SIN	●		●	●		●	●	●
TAN			●	●		●	●	●

	ATARI	APPLE INTEGER	APPLESOFT	EXIDY	TRS 80 LEVEL I	TRS 80 LEVEL II	TRS 80 DOS	PET
STRING								
ASC	●	●	●	●		●	●	●
CHR$	●		●	●		●	●	●
INSTR							●	
LEFT$			●	●		●	●	●
LEN	●	●	●	●		●	●	●
MID$			●	●		●	●	●
RIGHT$			●	●		●	●	●
STRING$						●	●	
STR$	●		●	●		●	●	●
VAL	●		●	●		●	●	●
OTHERS								
DEF_FN			●	●			●	●
FRE	●		●	●		●	●	●
MEM					●	●	●	
TI								●
TI$								●
TIME$							●	
CONTROL OF PGM FLOW								
BRANCHES								
GOTO	●	●	●	●	●	●	●	●
IF-THEN	●	●	●	●	●	●	●	●
ELSE						●	●	
ON-GOTO	●		●	●		●	●	●
SUBROUTINES								
GOSUB	●	●	●	●	●	●	●	●
RETURN	●	●	●	●	●	●	●	●
POP	●	●	●					
ON-GOSUB	●		●	●		●	●	●
LOOPS								
FOR	●	●	●	●	●	●	●	●
NEXT	●	●	●	●	●	●	●	●
STEP	●	●	●	●	●	●	●	●
OTHER								
END	●	●	●	●	●	●	●	●
STOP	●		●	●	●	●	●	●
REM	●	●	●	●	●	●	●	●
INPUT / OUTPUT								
INTERNAL								
DATA	●		●	●	●	●	●	●
READ	●		●	●	●	●	●	●
RESTORE	●		●	●	●	●	●	●
KEYBOARD								
GET			●					●
INKEY$						●	●	
INPUT	●	●	●	●	●	●	●	●
LINE INPUT							●	
TO SCREEN								
PRINTING								
PRINT	●	●	●	●	●	●	●	●
PRINT AT,@					●	●	●	
PRINT USING						●	●	
SPEED			●					
NULL				●				
TABULATION								
HTAB			●					
VTAB		●	●					
POS			●	●		●	●	●
SPC			●	●				●
TAB			●	●	●	●	●	●
MODES, MOTION								
Cursor Movements	●	●	●	●		●	●	●
CLS					●	●	●	
HOME			●					
FLASH			●					
INVERSE			●					
NORMAL			●					
TEXT		●	●					

	ATARI	APPLE INTEGER	APPLESOFT	EXIDY	TRS 80 LEVEL I	TRS 80 LEVEL II	TRE 80 DOS	PET
FILES								
GENERAL								
CLOSE	●						●	●
CMD								●
GET#								●
INPUT#	●				●	●	●	●
OPEN	●						●	●
PRINT#	●				●	●	●	●
STATUS	●							
STORE			●					
RECALL			●					
DISC								
Type Conversions								
CVD							●	
CVI							●	
CVS							●	
CDBL						●	●	
CINT						●	●	
CSNG						●	●	
MKD$							●	
MKI$							●	
MKS$							●	
Pointers								
EOF							●	
KILL							●	
LOC							●	
LOF							●	
NOTE	●							
POINT	●							
XIO	●							
Data Xfers								
FIELD							●	
GET	●						●	
PUT	●							
LSET							●	
RSET							●	
COMMANDS								
PROGRAM CONTROL								
CLEAR			●	●		●	●	
CLEAR n				●		●	●	
CLR	●	●						●
CON		●						
CONT	●		●	●	●	●	●	●
NEW	●	●	●	●	●	●	●	●
RUN	●	●	●	●	●	●	●	●
DISPLAY								
LIST	●	●	●	●	●	●	●	●
LLIST						●	●	
LPRINT	●					●	●	
OFF-LINE STORE								
CLOAD	●			●	●	●	●	
CLOAD?						●	●	
CSAVE	●			●	●	●	●	
ENTER	●							
LOAD	●	●	●					●
MERGE							●	
SAVE	●	●	●					●
VERIFY								●
EXITING								
BYE	●			●				
DOS	●							
EDITING								
Abbreviations	●				●			●
AUTO		●				●	●	
DEL		●	●					
DELETE						●	●	
EDIT						●	●	
MAN		●						
Multistatement Lines		●	●	●	●	●	●	●
Screen Editor	●							●
Line Editor		●	●			●	●	
DEBUGGING AIDS								
Direct Mode	●	●	●	●	●	●	●	●
DSP		●						
NO DSP		●						
TRACE		●	●					
NO TRACE		●	●					
TRON						●	●	
TROFF						●	●	

	ATARI	APPLE INTEGER	APPLESOFT	EXIDY	TRS 80 LEVEL I	TRS 80 LEVEL II	TRS 80 DOS	PET
ERRORS								
MESSAGES								
English		●	●					●
Cryptic	●●			●	●	●	●	
TRAPS								
ON ERR GOTO			●			●	●	
RESUME			●			●	●	
TRAP	●							
ERR						●	●	
ERROR #						●	●	
ERL						●	●	
NOT SO BASIC								
MACHINE LANGUAGE HOOKS								
CALL		●	●					
SYS								
SYSTEM								●
USR	●		●	●		●	●	●
ADR	●							
VARPTR						●	●	
WAIT			●	●				●
DEFUSR							●	
HIMEM		●	●					
LOMEM		●	●					
INP				●		●	●	
OUT				●		●	●	
IN#		●	●					
PR#		●	●					
PEEK	●	●	●	●		●	●	●
POKE	●	●	●	●		●	●	●
GRAPHICS								
DIRECT CONTROL								
PEEK/POKE		●		●		●	●	●
ROM ROUTINES		●						
DISPLAY MODES								
GR		●	●					
GRAPHICS	●							
HGR			●					
HGR 2			●					
COLORS								
COLOR	●	●	●					
SETCOLOR	●							
HCOLOR								
DRAWING								
HLIN		●	●					
VLIN		●	●					
PLOT	●	●	●					
HPLOT			●					
HPLOT TO			●					
DRAW TO	●							
DRAW AT			●					
XDRAW			●					
ROT			●					
SCALE			●					
SHLOAD			●					
SET					●	●	●	
RESET					●	●	●	
SCREEN SENSES								
LOCATE	●							
POSITION	●							
POINT					●	●	●	
SOUND								
PEEK/POKE		●	●					●
Additional hardware								●
SOUND	●							
SENSING THE WORLD								
PEEK/POKE + hardware								●
PADDLE	●							
PTRIG	●							
PDL		●	●					
STICK	●							
STRIG	●							

Going Computer Shopping?



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The small business owner who knows what to look for in computers can have a long, profitable experience with a system virtually tailor-made to his or her needs. A wrong choice could leave that same entrepreneur with an expensive orphan. But to be a good shopper, you must be knowledgeable enough to ask the right questions.

In the crowded marketplace of small computers one hears all sorts of claims and counterclaims; all kinds of promises and pledges. Over the next five years, that marketplace will likely get more crowded. At latest count there were more than 150 different suppliers of small business systems, but in fact *hardware* from system to system is very similar. As far as computer *programs* go (the software, or the instructions that tell a computer what to do and when) one general ledger program is much like any number of others. So, how do you differentiate? What is the best system for *you?*

Deciding which computer is right for your operations, or whether a computer is the right way to go at all, is largely a matter of good planning.

Deciding which computer is right for your operations, or whether a computer is the right way to go at all, is largely a matter of good planning. Specifically, planning based on the realities of your particular business. Say you have made the decision to computerize. You have assessed your business situation and determined that the required investment is cost-effective for a service that will automate what previously cost more in clerical labor.

Your total investment will include everything — hardware, software, and installation. It is important at this point that you begin thinking of the computer as a solution — a way to solve your paper-handling problems. With that in mind, you can see why it is absolutely necessary to understand your problem — the business problem you want the computer to solve. Too many entrepreneurs do not. Along these lines, a frequent mistake — once the decision is made to computerize — is going for total automation. This is an invitation to trouble, because it takes a certain amount of time to accustom yourself, your employees, and your business to computerization. A better approach would be a slower, phasing-in of a business-wide computer system. This, again, is a function of how well you understand the problem you want the computer to solve.

Think About Tomorrow's Needs

Clearly define what you would want from a computer system. Include what you want today, and what you believe you will need a few years from now. As a general rule of thumb, figure on having the system work for you at least three years. At this point, however, we might offer some words of caution: Some manufacturers make a sincere attempt to quantify computer systems by size of business. In other words, you will hear a certain level of computer power described as "typical" for a business doing "under $1 million" in sales. In fact, it is virtually impossible to categorize computer need by size of business.

After you have defined the problem and have a rough idea of how much you would be willing to spend to solve it, a picture will begin to emerge of what you will need in the way of a solution. Owning and running your own business, it is unlikely that you will have the time to assess every make of computer in terms of your particular needs. The independent computer dealer does it for a living. Frankly, we cannot over-emphasize the importance of seeking out and talking to a reputable dealer. Not only is he an expert on small computers, but he is a small businessman himself. He can empathize with the problems of small business management and make it absolutely clear how a computer can help you run your business the way you want to run it. He supplies the best computer equipment he can find, and combines it with the application programs necessary for specific needs such as your own. (Application programs are the written instructions you apply to tell the computer what you want it to do, such as a certain accounting function.)

Choose Carefully

We recommend that you select a dealer with the careful deliberation on which you would choose an attorney, banker, or financial manager. The thing to look for is a dealer's record of success in solving business problems similar to yours. Remember, too, that if he is unwilling or unable to listen carefully to your particular business problem, and provide you with a "hands-on" demonstration of a system *specific to your business needs,* beware. Take your business to someone who understands your problems.

We recommend that you select a dealer with the careful deliberation on which you would choose an attorney, banker, or financial manager.

There are plenty of horror stories about computer buyers who are undersold as well as oversold. One individual we know of who purchased a relatively inexpensive, so-called personal computer recently, soon discovered that it simply would not do the kinds of jobs his business would eventually require. He was left with several thousand dollars worth of essentially useless computer hardware. On the other hand, we know of too many instances in which unwary buyers purchased more computer power than they would ever need. The moral here, again, is to know precisely where your business is today and where it is heading tomorrow — and the next few years. A computer system capable of supporting 20 terminals is not for you if, after consultation with a dealer, you have established a need for six. Another thing to keep in mind is the importance of *modular growth*. By this, we mean your computer system should be expandable — able to grow with your business in increments. For example, a computer system that runs your accounts receivable — giving you up-to-minute information and reports on who owes you what, when, and for how long — might be the perfect solution for your problem now. But, as your organization grows, you will likely want and need a more extensive system that offers inventory control and customer mailing lists. You might well need another terminal or two. Be sure the system in which you invest can easily grow with you at minimal cost. Avoid the situation where you will be forced to convert to an entirely new and different system. Here, again, consult your dealer and clearly spell out the requirements of your business.

The small business system is a tool that provides quick, inexpensive access to information important to your business. Naturally, how you apply that information is purely a function of your own business ability. If you are a good business manager to begin with, your small business computer will very likely enhance that. It will help you make better forecasts, help you be more confident in your business decisions, reduce operating costs, and help you provide better customer service.

Cutting your operating costs — lowering the costs of doing business — takes on even more importance in an era of economic uncertainty, particularly in inflationary times. A few years ago it was important for a small business to track costs and plan profits. Today, it is a matter of survival. The point is that the tools are now available to help you deal successfully with a changing — and not always pleasant — economic environment. To dismiss the computer as something you can do without simply because you always have done without one runs contrary to a very basic law of nature, as well as business — that whoever cannot adapt to a changing environment is doomed to extinction.

Be sure the system in which you invest can easily grow with you at minimal cost.

Successful entrepreneurs have long been aware that business success blends science and art. While the art is up to you, the small business computer has advanced the science to a new height and put it within reach. What the small business computer cannot do — and will likely never be able to do — is turn a poor manager into a good one. Your ultimate business decisions rest with you.

Talking in general terms about small business computers, especially what they can do for the individual business, poses hazards, simply because of the vastness and diversity of small business itself. Hence, the usefulness of talking to an independent dealer. It should be noted, however, that small business computers are making their presence felt in a dramatically increasing number of installations worldwide. They are finding homes in as wide a variety of small businesses as the number would seem to indicate. At the end of 1978, according to industry surveys, more than 70,000 small business systems had been installed. By 1980, the figure is expected to jump to more than 135,000, and by the end of 1982, more than a quarter of a million computers will be at work.

You owe it to yourself to determine if the small business computer is good business for you. ☐

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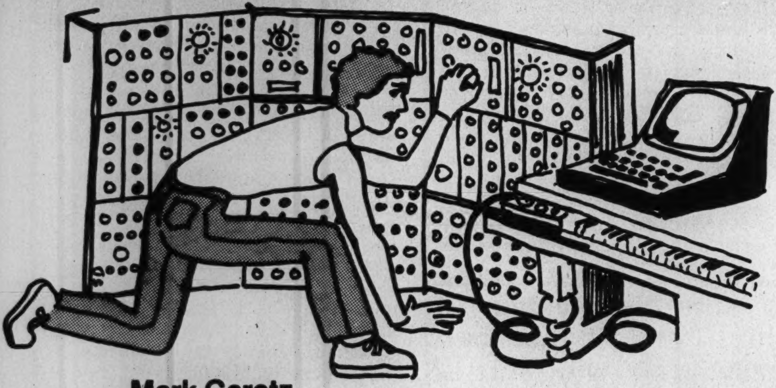

Confessions of a Micropath

Is there any hope?

Mark Garetz

Reminiscences of the Good Old Days—over five years ago! Incidentally, since this publication now forbids the word "microcomputer," the title presents paradoxes of its own—but it's a nice term.

My wife has a new word the she uses to describe me, relative to my love for little computers—micropath, which, if you haven't already figured it out, is a derivation of psychopath. And, I guess, looking back on the almost 5 or so years that I have been involved with microprocessors and their related sundry hardware, she's right.

At times I will disappear into the computer room and emerge hours later bleary-eyed and cursing about a piece of hardware or a software routine that won't work the way it should, or at least the way I thought it should. She usually offers me encouragement, though, gives me something cold to drink and off I go back to slug it out with the stubborn computer for a few more hours.

Let me start at the beginning, how I got into all this and why. I play the synthesizer (an electronic music device) but I really don't have the talent or the patience to become a keyboard virtuoso. This was frustrating, but at least in electronic music you can get away without playing the keyboard of the synthesizer very well, as long as you have a multi-track tape machine and an ear for what sounds good. In fact, some synthesizers don't even have keyboards.

When synthesizers first appeared commercially, about 1964, I longed to have one but my extremely limited budget wouldn't allow that. So I decided to build one. I had dabbled in electronics a bit before (I'd built a few unsuccessful kits and a thing or two out of Popular Electronics) so I felt reasonably confident that I could produce a synthesizer as good as the commercial units. (Boy, was I naive!) This is how I really started to get involved in electronics.

Well, I struggled with the synthesizer for a few years and then my financial situation improved to the point where I could afford a real synthesizer and a multi-track tape machine. I still needed more "modules" for my system so I decided to build them. My electronics knowledge had grown over the years so those came out OK. I started fixing synthesizers for other people in my spare time.

There was this guy named Bob Marsh who had started a small company known as Processor Technology, and Roger Mellen who had a little company with the strange name of Cromemco and a silver-haired sage by the name of Gordon French who had a computer that worked!

This was about the time that the pong game appeared in pizza parlors, bars and other such places. A friend of a friend knew someone who knew someone who could get us the PC board for a four-player Pong-Hockey game made by one of Atari's competitors for about $50 with most of the IC's set into place but not soldered. The board had about 95 TTL IC's on it. We said, "Sure." I don't know if my friend ever got his working, but I wasn't going to let $50 go down the drain.

Eventually I got it to work and I was one of the first people to have my own Pong game. About a year later Atari introduced their first home model. Meanwhile I ran into a person named Ned Lagin who was hooked up with the Grateful Dead (for those of you who never emerge from your respective computer rooms, the Grateful Dead is a rock group) and he played the synthesizer and was using an Interdata mini-computer to control it. He was working on an album (Seastones—Lagin and Lesh) and was using the computer extensively in its production. He also used the computer in live performances as a quasi-intelligent performer that responded to events happening on stage. This was all very exciting!

About a month after I met Ned, that first fateful article appeared in Popular Electronics describing the Altair. The Altair certainly was cheaper than Ned's Interdata and conceivably within my budget. Could I use the Altair to do the same kind of things with my synthesizer as Ned was doing with his?

I immediately rushed over to Ned's to show him the article. He informed me that he had already placed his order. I decided to hold off and do some more research since I knew absolutely nothing about computers.

At that point in time hardly anybody knew anything about chip computers and there certainly weren't any books on the subject—Intel Product Literature was about it. I discovered the Mark-8 computer articles—an 8008-based system. Godbout Electronics was selling 8008 chips for about $50, so I thought I would look deeper into building an 8008 system from scratch.

Well, the 8008 is a real strange little chip, and it's even stranger when you don't understand anything. This put me off the 800 series from Intel. About the same time Motorola had announced the 6800. I rushed down to the local distributor and paid

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Mark Garetz, 1429 Maple St., San Mateo, CA 94402.

$35 for the giant Motorola manuals and also gathered up all the free literature I could. The Motorola manuals were confusing and not very clearly written. They make perfect sense now, but now I'm not a novice.

Even though the Motorola manuals were confusing, they were great compared to what Intel had released, which was downright cryptic! Little glimmers of understanding were flashing in my brain.

Enter the Godsend—The Homebrew Computer Club! At that time Homebrew, as we call it, was about fifty guys crammed into a little classroom (The Orange Room) on the grounds of the Stanford Linear Accelerator, who were all about in the same boat as I was. We were all learning and gaining insights from each other. There was this guy named Bob Marsh who had started a small company known as Processor Technology, and Roger Mellen who had a little company with the strange name of Cromemco and a silver-haired sage by the name of Gordon French who had a computer that worked! Steve Dompier was playing "Fool on the Hill" from his Altair, broadcasting the switching noise over an AM radio. These were exciting times. We were all pioneers (now I know how to tell the pioneers—they're the ones with the arrows in their chests). Homebrew has now grown to over a thousand members.

I would like to point out that no one has really credited Chuck Peddle for bringing the microprocessors within reach of all of us.

By now it was August and these strange ads had appeared from a company called MOS Technology. They were announcing a new line of microprocessors for $20 and up. $20.00! And, they said you could buy the things at the upcoming Wescon show in September. This was unheard of. Remember that at this time an 8080 was still $175.00.

What a furor this created. Intel and Motorola seemed to be implying that the $20 price was a phony come-on, like you could only get that price if you ordered a million units. Other people were convinced that it was an out-and-out fraud. One salesman I talked to was convinced of this, and I remember him distinctly telling me that the microprocessor chips had reached their bottom price—$175—and that we'd never see them go any lower. I countered by saying that soon we'd see the price of microprocessors drop to under $10 in the next year or so. He said "Never!"—told me I was crazy and everyone else standing around agreed with the salesman.

The only thing to do was to wait and see what happened at Wescon. Well, along came the day of the show and, sure enough, there was MOS Technology but no chips in sight. I was informed that no selling was allowed on the floor, but that the chips were available in their hospitality suite. Away I went to the hospitality suite to find out the real story.

There they were! A big glass bowl of chips and stacks of manuals. They also had a KIM and a TIM system running. A guy named Chuck Peddle was there, happy to explain the features of his newly born baby. They plied me with a drink and I sat down on one of the couches with a copy of the manual to have a look. The damn thing made sense. Take my money!

I went home that evening with a 6502 chip and a hardware and software manual. My own computer and all for $25 dollars. Little did I know that I would invest another $300 before my homebrew 6502 system would work.

I still needed more "modules" for my system so I decided to build them.

It is interesting to note that this very day Intel and Motorola announced price reductions on their processors to $79.00. The microcomputing craze was really beginning. I would like to point out that no one has really credited Chuck Peddle for bringing the microprocessors within reach of all of us.

Everyone with an Altair or Imsai seemed to have Microsoft Basic running or Li Chen Wang's Palo Alto Tiny Basic and all kinds of games were proliferating at Homebrew. However, I was now stuck with a 6502 system and there was no 6502 Basic out, or any other applications program for that matter. A guy who worked for HP had designed a 6502 system with an integral video display, cassette interface and 8K of memory on board (8K was a lot in those days) and he was writing a 6502 integer Basic for it. He showed it to all at Homebrew, but since he had designed it at HP, he wasn't sure he could release any of it to us with 6502's.

That guy was Steve Wozniak who, when he finally did get permission to release the stuff, teamed up with Steve Jobs, another Homebrew member, to form the Apple Computer Co.

An insatiable appetite for whatever is new, be it hardware or software, is the sign of a true micropath. As an example, my collection of hardware grew to the point where I had:

6502 Homebrew System
Imsai w/Cromemco ZPU
TRS-80 Level II Disk System
Commodore PET
RCA COSMAC VIP
Zilog MCB (Single Board Computer)
General Automation SPC-16 w/12K
Processor Technology SOL
ASR-33 TTY
Selectric Printer
North Star Disks,
speech synthesizers, video displays, cassette interfaces and more.

And I just got an 8086 chip set and will probably get a Z-8000 before too long. Now you can see where my wife got the word micropath.

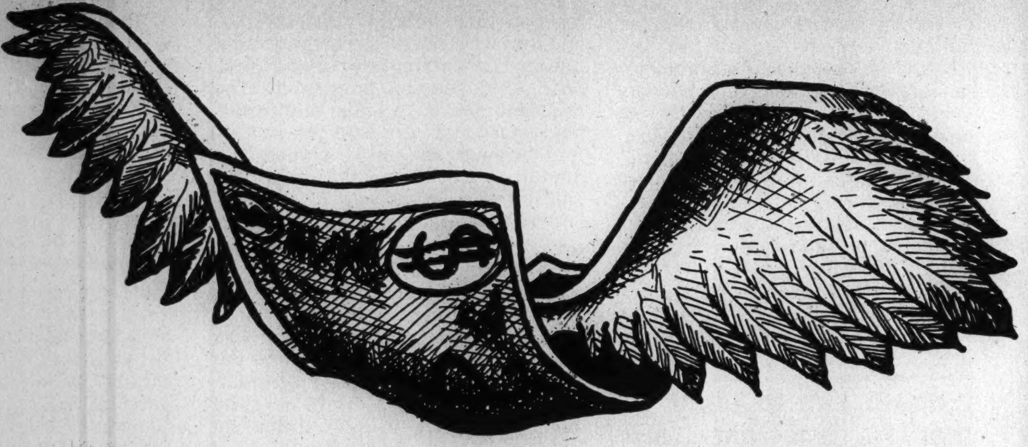
Somewhere along the line I had to start my own microprocessor company — HUH Electronics — just to support my habit.

But I'm slowing down. Some of the equipment in the above list has been sold. HUH Electronics has merged into California Computer Systems and now I'm an independent consultant.

By now you may be wondering why I called this article "Confessions of a Micropath." I have one big confession to make and that is, that in all the years I've been involved with microprocessors, I really haven't done anything useful with them. The closest I've gotten is that I'm using the Electric Pencil right now to type this article. I never got the computers hooked up to my synthesizers; in fact, the computers take up so much room that I've had to put the synthesizers in the closet.

Somewhere along the line I had to start my own microprocessor company —HUH Electronics—just to support my habit.

So if you're a micropath, or are heading in that direction, don't worry about trying to justify your hobby to thems what don't know. Those of us that are considered experts in this field don't do a hell of a lot with our computers either. We don't have the time. We're busy finding out what's new! □



Stocks and Listed Options

Part 3-Call Option Writing and Program OPTION

Alfred Adler Ph.D

Review

In Part 1 of this series we introduced the reader to stocks and the stock market. We pointed out that a share of common stock is not a debt instrument, as is a bond, but rather represents part ownership in a venture. The stock market was presented as a place where buyer and seller, or their representatives, meet and engage in an auction. Brokers were discussed as the usual form of representative, and the reader was introduced to the harsh realities of life in the form of the ubiquitous commission. The differences in possible investment attitudes were touched on briefly, and the discussion then moved to puts and calls and the listed option markets. One or two of the more obvious option strategies were mentioned and a Table was presented comparing the profits and losses that could be realized by various modifications to these strategies.

In Part 2 the discussion of option strategies was continued with a brief presentation of the six basic strategies. The discussion then moved on to combination strategies, with covered and uncovered calls, and covered and uncovered straddles receiving fairly detailed treatment.

Program OPTION permits the examination of a large number of possible maneuvers in a short time.

By now the reader should be fairly familiar with the terminology, the rights and responsibilities of option writers and buyers, and the profit versus stock price graphs for the six basic maneuvers. From this point on it will be assumed that the reader has read the previous articles in the series, and can refer to them as necessary.

Call Writing

In Part 1 of this series it was stated that covered call writing is "more conservative and more consistently profitable than the simple buying and selling of stocks." It was also mentioned that "very conservative financial institutions...have begun trading options." The vast majority of their option trading is covered call writing. Thus this particular strategy is without a doubt the most popular single stock/option strategy engaged in today. It is certainly fitting that we examine it in some detail and prepare whatever programs are necessary to assist.

In Part 2 of this series call writing was discussed in terms of profit versus stock price on expiration day. However, before one sells calls against a long stock position it might

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be desirable to have additional information on the other possible outcomes as well as a more complete statement of the implied input data.

Before getting involved in the details, it is necessary to distinguish between an opening option transaction and a closing option transaction. They are quite different and will be treated separately. An opening option transaction occurs when an option not previously owned is sold or when an option not previously sold, is bought. A closing option transaction occurs when a previously bought option is sold, or when a previously sold option is bought back. All option transactions are either opening transactions or closing transactions. There is no other kind. The option involved in a closing transaction must be the same, meaning the same underlying stock, the same expiration date, and the same exercise price, as the option involved in the corresponding opening transaction. A closing transaction, in short, is a termination of a position acquired through an opening transaction.

Opening Transactions

Calls may be sold against an existing long stock position or against a position taken simultaneously with the sale of the calls. If the former, then the seller creates an immediate cash credit in the amount of the net proceeds of the option sale. If the latter, then the cost of the stock purchased is diminished by the net proceeds of the option sale. By "net" is meant the total premium income minus the commissions on the option sale. It would be interesting to have a statement of the cost of the stock purchased, if any, as well as the cost of the total amount of stock committed to the strategy. In addition, it would be informative to have a further breakdown into the net sale proceeds of the options: the net purchase, that is, the cost of stock purchased minus the net option proceeds, and the net sum committed, that is, the total cost of stock committed minus net option proceeds. It would be further desirable to have a statement of the time to expiration, the lower breakeven point both in dollars and in percent, and The same for the upper breakeven point, if any.

All option transactions are either opening transactions or closing transactions.

Most important, a statement of the income, if the options are permitted to expire, in dollars, percent, and annualized percent; and a statement of the profit, broken down into income and capital gain on the stock, if called, in dollars, percent, and annualized percent. "Income," as used above, is the sum of the net option proceeds and dividends, less margin interest. "Profit" is the sum of "income" and stock capital gains.

Closing Transactions

Before closing an existing option position it is certainly desirable to examine the consequences in some detail. In this case there are a number of alternative ways in which a closing transaction might be made. If options have been sold at a hedge ratio greater than 1, it might be desirable to sell only the uncovered options while retaining those that are covered. This would probably be the case if the stock were inching up past the exercise price of the call. On the other hand if the option price has dropped precipitously, it might be wise to buy them back, hoping that the price will rise again and they can be resold. It is amazing how often this can be profitably done. This type of maneuver is a prime example of the importance of including broker's commissions in the calculations. Unless the price spread between the buyback and subsequent resale of the option is greater than the round trip commissions, there will be no profit except, of course, to the broker. Finally, if the underlying stock has become less attractive, it may be desirable to close out the entire position.

If a closing option transaction is made, the value of the net option proceeds changes. Whereas before it equaled the proceeds of the sale of the options less commission, now there is the additional deduction of the cost of repurchase and the repurchase commission. A statement of the new net option proceeds

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
FEB	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59			
* MAR	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
* APR	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	
* MAY	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
* JUNE	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
* JULY	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212
* AUG	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243
* SEPT	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
* OCT	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
* NOV	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	
* DEC	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365

* In leap years, after Feb 28, add 1 to the tabulated number.

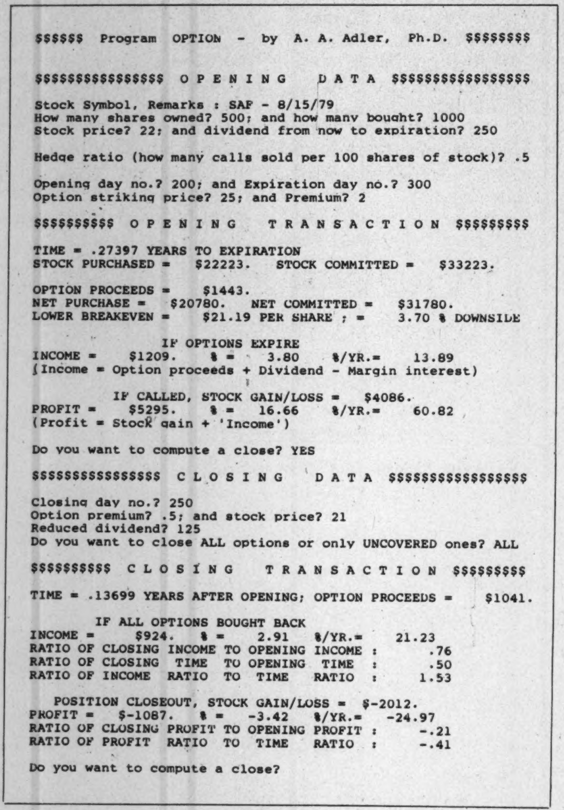
Figure 1

as well as the time since the opening transaction is certainly desirable. In addition, a revised value for the income (option proceeds + dividends – margin interest), in dollars, percent, and annualized percent, is needed. Several indices of the desirability of making the proposed closing option transaction are valuable. First we want to look at the ratio of the income if we make this closing transaction to the income anticipated when we made the opening transaction. Next we want to look at the ratio of the elapsed time since the opening transaction to the elapsed time to expiration anticipated when we made the opening transaction. Finally, we want to look at the ratio of these 2 ratios. Suppose, for example, we find that the income ratio is .87, and the time ratio is only .36. The ratio of these two ratios is 2.4, which means that we have made our profit (in dollars per unit time) at 2.4 times the rate we anticipated at opening time. This parameter may certainly influence our decision regarding the desirability of making the closing transaction.

Additional data is desired if a total position closeout is being considered. A revised profit (income + capital gain on stock) is needed, in dollars, percent, and annualized percent. A minor revision is also needed in the ratio indices. Instead of an income ratio, we now need a profit ratio. The time ratio is unchanged, so that instead of the final index being the ratio of the income ratio to the time ratio, it is now the ratio of the profit ratio to the time ratio.

Program Option

Program OPTION has been designed to furnish the output parameters discussed above. Before running, some personalization is required. As supplied, the program computes commissions assuming a 35% discount from the usual rates, and margin interest at 8.5%. Both of these values should be adjusted by the user to meet his needs in accordance with the instructions furnished with the program.



```
$$$$$$ Program OPTION - by A. A. Adler, Ph.D. $$$$$$$$

$$$$$$$$$$$$$$$$$ O P E N I N G   D A T A $$$$$$$$$$$$$$$$$$

Stock Symbol, Remarks : SAF - 8/15/79
How many shares owned? 500; and how many bought? 1000
Stock price? 22; and dividend from now to expiration? 250

Hedge ratio (how many calls sold per 100 shares of stock)? .5

Opening day no.? 200; and Expiration day no.? 300
Option striking price? 25; and Premium? 2

$$$$$$$$$$ O P E N I N G   T R A N S A C T I O N $$$$$$$$$

TIME = .27397 YEARS TO EXPIRATION
STOCK PURCHASED =   $22223.   STOCK COMMITTED =   $33223.

OPTION PROCEEDS =    $1443.
NET PURCHASE =   $20780.   NET COMMITTED =   $31780.
LOWER BREAKEVEN =    $21.19 PER SHARE ; =    3.70 % DOWNSIDE

                IF OPTIONS EXPIRE
INCOME =    $1209.    % =   3.80    %/YR.=    13.89
(Income = Option proceeds + Dividend - Margin interest)

          IF CALLED, STOCK GAIN/LOSS =   $4086.
PROFIT =    $5295.    % =   16.66    %/YR.=    60.82
(Profit = Stock gain + 'Income')

Do you want to compute a close? YES

$$$$$$$$$$$$$$$$ C L O S I N G   D A T A $$$$$$$$$$$$$$$$$$

Closing day no.? 250
Option premium? .5; and stock price? 21
Reduced dividend? 125
Do you want to close ALL options or only UNCOVERED ones? ALL

$$$$$$$$$$ C L O S I N G   T R A N S A C T I O N $$$$$$$$$

TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS =    $1041.

        IF ALL OPTIONS BOUGHT BACK
INCOME =     $924.   % =    2.91   %/YR.=    21.23
RATIO OF CLOSING INCOME TO OPENING INCOME :       .76
RATIO OF CLOSING  TIME  TO OPENING  TIME  :       .50
RATIO OF INCOME  RATIO  TO  TIME   RATIO  :     1.53

   POSITION CLOSEOUT, STOCK GAIN/LOSS =  $-2012.
PROFIT =   $-1087.   % =   -3.42   %/YR.=   -24.97
RATIO OF CLOSING PROFIT TO OPENING PROFIT :      -.21
RATIO OF PROFIT  RATIO  TO  TIME   RATIO  :      -.41

Do you want to compute a close?
```

Figure 2

It should be noted that the margin interest is computed by the program assuming that the margin debit is the entire net purchase, not just the percentage marginable under FRB regulations. It has been done this way since an investor with a portfolio large enough to be eligible to trade in options usually has sufficient capital that the current transaction under consideration can and will be put fully on margin. If it is desired to change this, the simplest way is to suitably alter the margin interest rate. For example, to change the margin debit to 50% of net purchase, simply change the interest rate in the program to one half the true interest rate. This is fully discussed in the instructions included in the program.

Before running Program OPTION, some personalization is required.

Following the run command the program will prompt the user to furnish the OPENING DATA. As can be seen in the sample runs further on in this article, the OPENING DATA consists of an identifying stock symbol and possibly a date or other remarks, the number of shares of underlying stock owned, the number of shares to be bought, the difference being in the commission to be charged against the transaction, the stock price, and the dividend expected between opening and expiration. The hedge ratio is also required. Finally, the opening day number, the expiration day number, the option exercise or striking price, and the option premium. The "day numbers" refer to the number of days since the beginning of the year. For example, May 24 is day number 144 (unless it is a leap year). Day numbers may be found in many reference books, such as The World Almanac. A table of day numbers is included in this article, see Figure 1. The reader may find it convenient to post it near the keyboard. The author has a master copy which is Xeroxed each year and the option expiration days for that year (the third Friday of each month) are underlined before posting.

The program is set up to handle hedge ratios between zero and infinity, not inclusive.

Following the entry of the OPENING DATA, the program will compute the important parameters of an OPENING TRANSACTION. Note that the income and profit percent-

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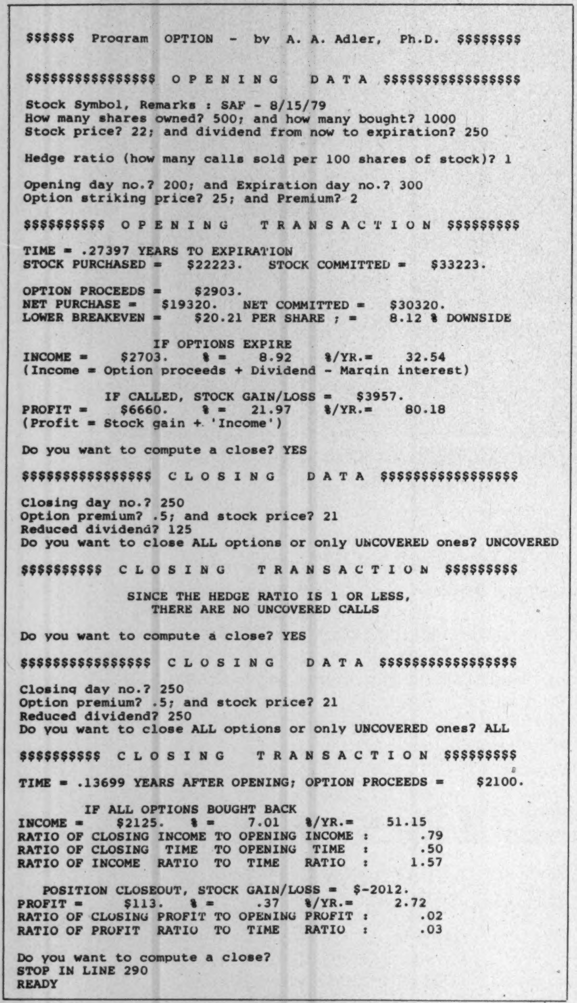
Investment, cont'd...

ages are computed on the basis of the NET COMMITTED, not on this basis reduced by the margin debit. In other words, the percent INCOME and the percent PROFIT are percentages of the dollar amount placed at risk, not the dollar amount advanced by the investor. It is a favorite ploy of brokers, even those intelligent enough to know better, to state percent profits to clients in terms of the amount of money the client puts up, as if the money borrowed is not the client's responsibility. This becomes the theatre of the absurd when the client has sufficient securities in his account that he need put up little or no money to make a purchase. If an investor buys $10,000 worth of stock and puts up only $100, the remainder becoming margin debit, the stock only needs to rise by $100, or 1%, in order for him to double his money according to this way of figuring. No such convenient logic appears in any of these programs.

Note that if the hedge ratio is less than 1, the IF CALLED, STOCK GAIN/LOSS is computed assuming for commission purposes that the only shares sold are those called. The GAIN/LOSS on the remaining shares is computed without commission. The POSITION CLOSEOUT, STOCK GAIN/LOSS, on the other hand, is computed assuming that all shares are sold.

Following the presentation of the OPENING TRANSACTION parameters Program OPTION will ask if a CLOSING TRANSACTION is desired. If "yes," prompts will be displayed requesting CLOSING DATA. Note that the reduced dividend requested refers to the possible reduction in dividend due to the fact that the time from the opening transaction to the closing transaction is less than the time from the opening transaction to expiration. At this point the user must decide whether he wants to close out "all" options or only those that are "uncovered." Of course, if the hedge ratio is 1 or less, there are no uncovered options and the user must respond with "all" or risk an uncomplimentary error return. If the user responds with "all," the income information and the profit informa-



```
 $$$$$$  Program  OPTION  -  by  A. A. Adler,  Ph.D.  $$$$$$$$


 $$$$$$$$$$$$$$$$  O P E N I N G    D A T A  $$$$$$$$$$$$$$$$

 Stock Symbol, Remarks : SAF - 8/15/79
 How many shares owned? 500; and how many bought? 1000
 Stock price? 22; and dividend from now to expiration? 250

 Hedge ratio (how many calls sold per 100 shares of stock)? 1

 Opening day no.? 200; and Expiration day no.? 300
 Option striking price? 25; and Premium? 2

 $$$$$$$$$$  O P E N I N G    T R A N S A C T I O N  $$$$$$$$$

 TIME = .27397 YEARS TO EXPIRATION
 STOCK PURCHASED =   $22223.   STOCK COMMITTED =   $33223.

 OPTION PROCEEDS =    $2903.
 NET PURCHASE =   $19320.   NET COMMITTED =   $30320.
 LOWER BREAKEVEN =    $20.21 PER SHARE ; =    8.12 % DOWNSIDE

                   IF OPTIONS EXPIRE
 INCOME =    $2703.    % =    8.92    %/YR.=    32.54
 (Income = Option proceeds + Dividend - Margin interest)

           IF CALLED, STOCK GAIN/LOSS =   $3957.
 PROFIT =    $6660.    % =   21.97    %/YR.=    80.18
 (Profit = Stock gain + 'Income')

 Do you want to compute a close? YES

 $$$$$$$$$$$$$$$$  C L O S I N G    D A T A  $$$$$$$$$$$$$$$$

 Closing day no.? 250
 Option premium? .5; and stock price? 21
 Reduced dividend? 125
 Do you want to close ALL options or only UNCOVERED ones? UNCOVERED

 $$$$$$$$$$  C L O S I N G    T R A N S A C T I O N  $$$$$$$$$

             SINCE THE HEDGE RATIO IS 1 OR LESS,
                THERE ARE NO UNCOVERED CALLS

 Do you want to compute a close? YES

 $$$$$$$$$$$$$$$$  C L O S I N G    D A T A  $$$$$$$$$$$$$$$$

 Closing day no.? 250
 Option premium? .5; and stock price? 21
 Reduced dividend? 250
 Do you want to close ALL options or only UNCOVERED ones? ALL

 $$$$$$$$$$  C L O S I N G    T R A N S A C T I O N  $$$$$$$$$

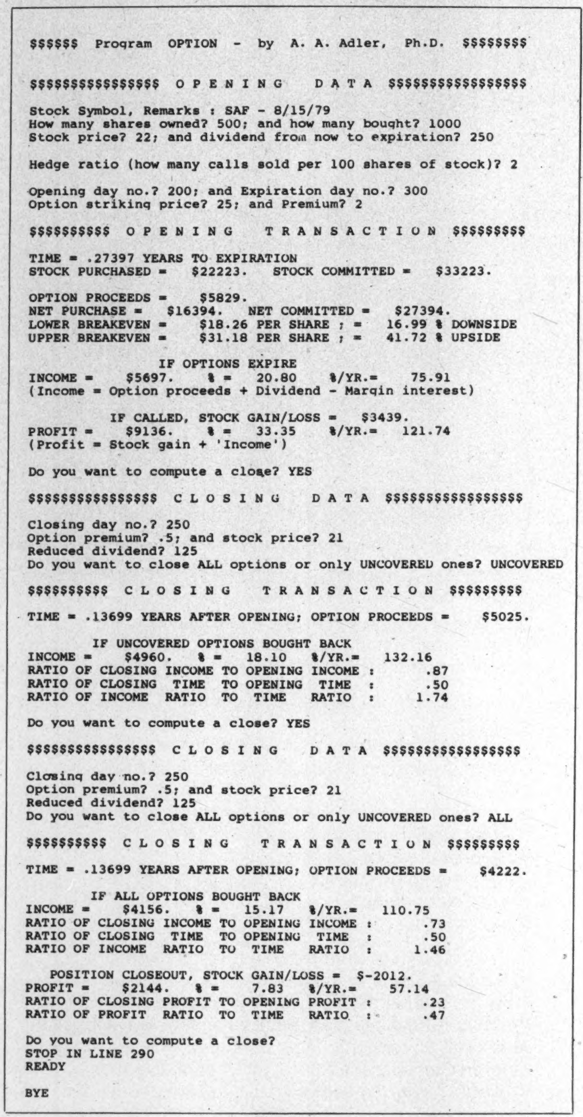
 TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS =    $2100.

        IF ALL OPTIONS BOUGHT BACK
 INCOME =    $2125.   % =     7.01   %/YR.=    51.15
 RATIO OF CLOSING INCOME TO OPENING INCOME :       .79
 RATIO OF CLOSING  TIME  TO OPENING  TIME  :       .50
 RATIO OF INCOME  RATIO  TO  TIME   RATIO  :      1.57

    POSITION CLOSEOUT, STOCK GAIN/LOSS =  $-2012.
 PROFIT =     $113.   % =      .37   %/YR.=      2.72
 RATIO OF CLOSING PROFIT TO OPENING PROFIT :       .02
 RATIO OF PROFIT  RATIO  TO  TIME   RATIO  :       .03

 Do you want to compute a close?
 STOP IN LINE 290
 READY
```

Figure 3



```
 $$$$$$  Program  OPTION  -  by  A. A. Adler,  Ph.D.  $$$$$$$$


 $$$$$$$$$$$$$$$$  O P E N I N G    D A T A  $$$$$$$$$$$$$$$$

 Stock Symbol, Remarks : SAF - 8/15/79
 How many shares owned? 500; and how many bought? 1000
 Stock price? 22; and dividend from now to expiration? 250

 Hedge ratio (how many calls sold per 100 shares of stock)? 2

 Opening day no.? 200; and Expiration day no.? 300
 Option striking price? 25; and Premium? 2

 $$$$$$$$$$  O P E N I N G    T R A N S A C T I O N  $$$$$$$$$

 TIME = .27397 YEARS TO EXPIRATION
 STOCK PURCHASED =   $22223.   STOCK COMMITTED =   $33223.

 OPTION PROCEEDS =    $5829.
 NET PURCHASE =   $16394.   NET COMMITTED =   $27394.
 LOWER BREAKEVEN =    $18.26 PER SHARE ; =   16.99 % DOWNSIDE
 UPPER BREAKEVEN =    $31.18 PER SHARE ; =   41.72 % UPSIDE

                   IF OPTIONS EXPIRE
 INCOME =    $5697.    % =   20.80    %/YR.=    75.91
 (Income = Option proceeds + Dividend - Margin interest)

           IF CALLED, STOCK GAIN/LOSS =   $3439.
 PROFIT =    $9136.    % =   33.35    %/YR.=   121.74
 (Profit = Stock gain + 'Income')

 Do you want to compute a close? YES

 $$$$$$$$$$$$$$$$  C L O S I N G    D A T A  $$$$$$$$$$$$$$$$

 Closing day no.? 250
 Option premium? .5; and stock price? 21
 Reduced dividend? 125
 Do you want to close ALL options or only UNCOVERED ones? UNCOVERED

 $$$$$$$$$$  C L O S I N G    T R A N S A C T I O N  $$$$$$$$$

 TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS =    $5025.

        IF UNCOVERED OPTIONS BOUGHT BACK
 INCOME =    $4960.   % =    18.10   %/YR.=   132.16
 RATIO OF CLOSING INCOME TO OPENING INCOME :       .87
 RATIO OF CLOSING  TIME  TO OPENING  TIME  :       .50
 RATIO OF INCOME  RATIO  TO  TIME   RATIO  :      1.74

 Do you want to compute a close? YES

 $$$$$$$$$$$$$$$$  C L O S I N G    D A T A  $$$$$$$$$$$$$$$$

 Closing day no.? 250
 Option premium? .5; and stock price? 21
 Reduced dividend? 125
 Do you want to close ALL options or only UNCOVERED ones? ALL

 $$$$$$$$$$  C L O S I N G    T R A N S A C T I O N  $$$$$$$$$

 TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS =    $4222.

        IF ALL OPTIONS BOUGHT BACK
 INCOME =    $4156.   % =    15.17   %/YR.=   110.75
 RATIO OF CLOSING INCOME TO OPENING INCOME :       .73
 RATIO OF CLOSING  TIME  TO OPENING  TIME  :       .50
 RATIO OF INCOME  RATIO  TO  TIME   RATIO  :      1.46

    POSITION CLOSEOUT, STOCK GAIN/LOSS =  $-2012.
 PROFIT =    $2144.   % =     7.83   %/YR.=    57.14
 RATIO OF CLOSING PROFIT TO OPENING PROFIT :       .23
 RATIO OF PROFIT  RATIO  TO  TIME   RATIO  :       .47

 Do you want to compute a close?
 STOP IN LINE 290
 READY

 BYE
```

Figure 4

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Investment, cont'd...

tion, as discussed above, is presented, otherwise only the income information is given. The program gives the user the opportunity to continuously recompute closing transactions using different data, as long as he pleases.

Sample Runs

As a demonstration of program operation several sample runs are offered. In Figure 2 an opening call transaction with a hedge ratio of .5 is presented, along with a closing transaction. In Figure 3 an opening transaction with a hedge ratio of 1 is presented, along with 2 closing transactions; one in which ALL the options are closed out; the other in which it is attempted to close out only the UNCOVERED options. Note the error return in the latter case. Figure 4 illustrates an opening transaction with a hedge ratio of 2. In this case the closing transactions with ALL the options closed, and with only the UNCOVERED options closed are shown.

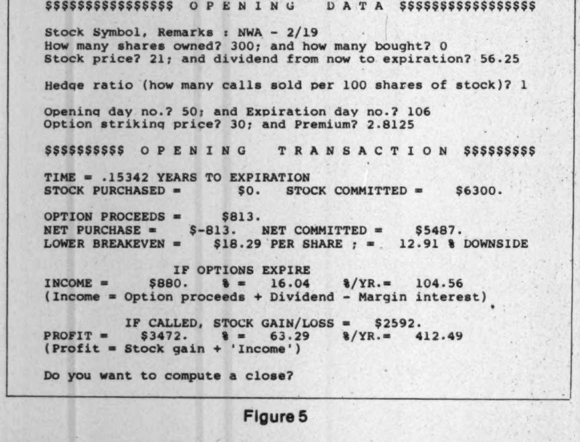
Hedging With Calls

Now that we have a program to do all the dog work, let us turn our attention to the writing of calls against stock positions specifically as a hedge. This is not a different strategy, but rather a change in emphasis; a different philosophy. We are now interested in using the call hedge to bias the odds of winning the investment game. We can use two different strategies; out-of-the-money call writing, and in-the-money call writing. These strategies can be expanded to include puts, of course, and can be made very involved and complex. Brokers like that; it brings in more commissions. It is certainly true however, that the simpler the strategy, the easier it is to *completely* understand and therefore to *completely* control. It is certainly cheaper in terms of commissions. It is extremely easy to get very involved in a many faceted and very complex multimaneuver, and end up with so many possible alternatives that when the market makes an unexpected turn, which it does just about half the time, utter confusion reigns, and all the beautiful runouts and safety plays which were bought so dearly just don't seem so beautiful anymore. We will discuss the 2 classes of hedges in their simplest form.

Covered call writing was discussed to some extent last month in connection with Program OPGRAPH. Now that Program OPTION is available we are able to examine the strategy in more detail and generate a complete set of real world output parameters.

The Out-Of-The-Money Hedge

The out-of-the-money hedge is easier to understand and certainly easier to accept, and will therefore be presented first. Some time ago the author had 300 shares of NWA, acquired at a price, including commissions, of $21. per share or $6300. At that time 3 April 30 calls were sold for $813, including commissions. These options had 56 days to go until expiration. As of expiration day, NWA was selling for less than $30 per share; therefore the option holder did not find it profitable to exercise his options and they expired worthless. A profit of $880 was therefore realized in 56 days on an investment of $6300 minus $813. This comes to 16.04% profit, but since it was made in .1534 years, the annualized profit is 104.56% per year. Note that the stock is still retained. The $880 profit includes $11 in reduced margin interest, since the margin debit is reduced by the $813 option proceeds. For those who do not habitually keep a margin debit, a quick modification to the program will wipe this element out. If the stock had moved above $30 per share, the profit would of course have been much greater. The complete story is shown in Figure 5.



```
$$$$$$  Program  OPTION  -  by  A. A. Adler,  Ph.D.  $$$$$$$$


$$$$$$$$$$$$$$$$ O P E N I N G   D A T A $$$$$$$$$$$$$$$$$

Stock Symbol, Remarks : NWA - 2/19
How many shares owned? 300; and how many bought? 0
Stock price? 21; and dividend from now to expiration? 56.25

Hedge ratio (how many calls sold per 100 shares of stock)? 1

Opening day no.? 50; and Expiration day no.? 106
Option striking price? 30; and Premium? 2.8125

$$$$$$$$$$ O P E N I N G   T R A N S A C T I O N $$$$$$$$$

TIME = .15342 YEARS TO EXPIRATION
STOCK PURCHASED =        $0.   STOCK COMMITTED =    $6300.

OPTION PROCEEDS =      $813.
NET PURCHASE =    $-813.   NET COMMITTED =    $5487.
LOWER BREAKEVEN =     $18.29 PER SHARE ; =   12.91 % DOWNSIDE

                 IF OPTIONS EXPIRE
INCOME =       $880.    % =   16.04    %/YR.=   104.56
(Income = Option proceeds + Dividend - Margin interest)

            IF CALLED, STOCK GAIN/LOSS =   $2592.
PROFIT =    $3472.    % =   63.29    %/YR.=   412.49
(Profit = Stock gain + 'Income')

Do you want to compute a close?
```

Figure 5

It is a favorite ploy of brokers to state percent profits to clients in terms of the amount of money the client puts up, as if the money borrowed is not the client's responsibility.

Meanwhile, 300 more shares of NWA had been purchased at a cost of $8508, including commission, bringing the total investment to $14808, or $24.68 per share. Two and one half months later, NWA was selling for over $30 per share so 6 October 35 calls were sold for a total of $1301 including commissions. The data covering the possible outcomes are shown in Figure 6. If the stock simply has the goodness not to fall below $22.51 per share nothing is lost. In other words, an 8.79% drop in stock price can be withstood before a loss is incurred. If the stock simply remains at $24.68, a 10.73% profit results. This is 32.93% per year; not bad for a stock that did absolutely nothing for 4 months! If the stock moves above $35 per share, then, of course, the gravy rolls in.

The In-The-Money Hedge

The out-of-the-money hedge is good when the investor is slightly bullish on the stock, that is, he expects it to at least remain the same or to rise slightly. The in-the-money hedge is better when the investor is

Investment, cont'd...

neutral, that is, he expects it to remain about the same. The reason for this is that in-the-money calls have a higher premium than out-of-the moneys. An out-of-the-money call has only time value, that is, the value of hope, the value induced by the possibility that the premium might rise before expiration time. In-the-money calls however, have intrinsic value in addition to time value. A call exercisable at $10 is worth no less than $2 if the underlying stock is selling at $12 per share, for example, since the buyer can call the stock at $2 per share less than the market price. These and other considerations will be discussed more fully next month when option premiums are studied in some detail.

As an example of an in-the-money call write, consider the following maneuver. On June 17, 1000 shares of HJ were bought for $12.75 per share. At the same time, 10 January 10 calls were sold. The reader is now wondering whether or not there is a misprint in the article. Stock was bought at $12.75 per share but calls were sold giving the buyer of the calls the right to grab the stock for $10 per share. How can you make money if stock is relinquished at less than cost? Very simply: when the cost of the privilege is greater than the loss on the stock, after all commissions are paid. In this case the cost of the privilege, which is of course the option premium, is $4.125 per share. This large value is due to the fact that the intrinsic value alone is $12.75 minus $10 or $2.75 per share. The difference, or $4.125 minus $2.75, is the time value of the option, $1.375 per share.

The complete transaction is presented in Figure 7. Note that although $12915 worth of stock was bought, only $8878 was required. This is a considerably larger discount than was obtained when out-of-the-money calls were sold. Note further the large amount of downside protection that is obtained in this type of maneuver. The stock can slide from $12.75 per share to $8.88 per share, a drop of 30.37% before a loss is incurred. If the stock remains above $10 per share the calls will expire worthless and a profit of 44.2% will be realized in 7 months. This works out to an annualized return of 75.4%. This is not a bad return on a stock that does not go up at all. If, on the other hand, the stock drops to $10 per share, that is by 27.5%, the calls are exercised and still a 9.71% profit is made. In this case the annualized rate is 16.55% which is not too hard to take for a stock that lost 27.5% of its value.

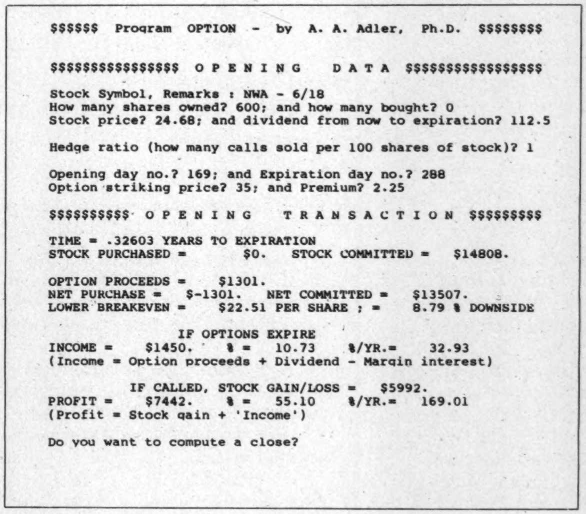
The program gives the user the opportunity to continuously recompute closing transactions using different data, as long as he pleases.

There always seems to be something very fishy about the in-the-money call write. However, if the reader who has never been exposed to this maneuver before will take the trouble to examine it very closely, he may find that he has latched on to something not only very interesting, but potentially quite profitable.

Conclusions

Call writing against already existing or concurrently established stock positions is more conservative and at the same time more profitable than simple long stock positions. It is therefore not surprising that it is also by far the most popular option hedging strategy. As is the case with all option strategies however, proposed positions must be examined carefully since both the opportunity for profit and the risk are sensitive to the variables and the commissions. Also as before, the calculations are long and tedious, especially when commissions are included; and they must be since commissions will often change an otherwise profitable maneuver into a losing venture. Program OPTION allows the user to perform such calculations quickly and easily, and permits the examination of a large number of possible maneuvers in a short time.

Program OPTION, along with OPGRAPH, presented last month, and the other 2 programs to be presented, is currently available on cassette for the TRS-80 16K Level II from Creative Computing Software, and on North Star disk, either single or double density, from the author. An Applesoft version is currently being written, and it is anticipated that other versions will be made available in the near future. ☐



```
$$$$$$  Program  OPTION  -  by  A. A. Adler,  Ph.D.  $$$$$$$$

$$$$$$$$$$$$$$$$ O P E N I N G   D A T A $$$$$$$$$$$$$$$$

Stock Symbol, Remarks : NWA - 6/18
How many shares owned? 600; and how many bought? 0
Stock price? 24.68; and dividend from now to expiration? 112.5

Hedge ratio (how many calls sold per 100 shares of stock)? 1

Opening day no.? 169; and Expiration day no.? 288
Option striking price? 35; and Premium? 2.25

$$$$$$$$$$ O P E N I N G   T R A N S A C T I O N $$$$$$$$$

TIME = .32603 YEARS TO EXPIRATION
STOCK PURCHASED =        $0.   STOCK COMMITTED =   $14808.

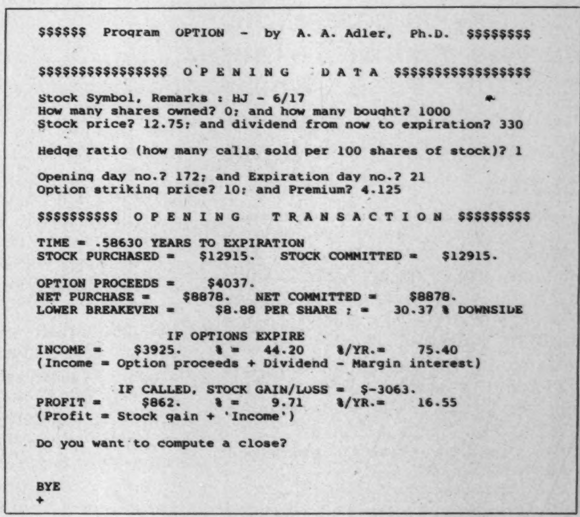
OPTION PROCEEDS =    $1301.
NET PURCHASE =   $-1301.   NET COMMITTED =   $13507.
LOWER BREAKEVEN =    $22.51 PER SHARE ; =    8.79 % DOWNSIDE

                IF OPTIONS EXPIRE
INCOME =    $1450.    % =    10.73    %/YR.=    32.93
(Income = Option proceeds + Dividend - Margin interest)

          IF CALLED, STOCK GAIN/LOSS =   $5992.
PROFIT =    $7442.    % =    55.10    %/YR.=   169.01
(Profit = Stock gain + 'Income')

Do you want to compute a close?
```

Figure 6



```
$$$$$$  Program  OPTION  -  by  A. A. Adler,  Ph.D.  $$$$$$$$

$$$$$$$$$$$$$$$$ O P E N I N G   D A T A $$$$$$$$$$$$$$$$

Stock Symbol, Remarks : HJ - 6/17
How many shares owned? 0; and how many bought? 1000
Stock price? 12.75; and dividend from now to expiration? 330

Hedge ratio (how many calls sold per 100 shares of stock)? 1

Opening day no.? 172; and Expiration day no.? 21
Option striking price? 10; and Premium? 4.125

$$$$$$$$$$ O P E N I N G   T R A N S A C T I O N $$$$$$$$$

TIME = .58630 YEARS TO EXPIRATION
STOCK PURCHASED =   $12915.   STOCK COMMITTED =   $12915.

OPTION PROCEEDS =    $4037.
NET PURCHASE =    $8878.   NET COMMITTED =    $8878.
LOWER BREAKEVEN =      $8.88 PER SHARE ; =   30.37 % DOWNSIDE

                IF OPTIONS EXPIRE
INCOME =    $3925.    % =    44.20    %/YR.=    75.40
(Income = Option proceeds + Dividend - Margin interest)

          IF CALLED, STOCK GAIN/LOSS =  $-3063.
PROFIT =     $862.    % =     9.71    %/YR.=    16.55
(Profit = Stock gain + 'Income')

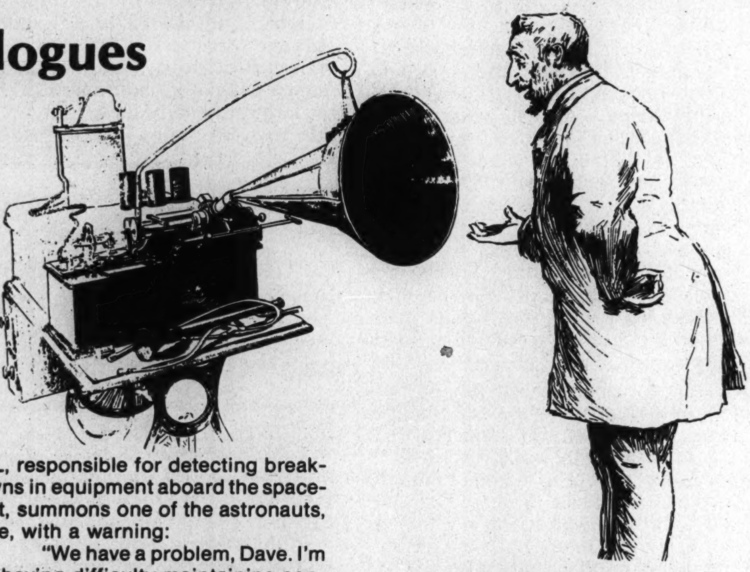
Do you want to compute a close?


BYE
+
```

Figure 7

Computer Mechanisms for Man-Machine Dialogues

Robert Branchek



The capability of computers to form intelligent answers to a human interrogator's questions has frequently astonished those unfamiliar with machine architecture and programming. Such surprise and awe are quite understandable, for some of the dialogues do appear indistinguishable from human conversations. An examination of several of these interactions — including comparisons among fictitious man-machine dialogue, actual people-computer dialogues, (and, implicitly, dialogues among humans) — should enable us to understand the nature of computer mechanisms.

When a keyword is not found in a sentence, Eliza must rely on generalized answers, such as "Tell me more" or "I see," which are acceptable answers to almost any input phrase.

Idealized computer interactions with humans have often been depicted in recent films. For example, in Stanley Kubrick's *2001,* a film based on the novel by Arthur C. Clarke, HAL, a bastardized IBM computer,* controls the entire operation of a manned spaceship exploring the outer planets. HAL, responsible for detecting breakdowns in equipment aboard the spacecraft, summons one of the astronauts, Dave, with a warning:

> "We have a problem, Dave. I'm having difficulty maintaining contact with Earth. The trouble is in the AE-35 unit. My fault prediction center reports that it may fail within 72 hours."
>
> Dave asks, "What procedure do you suggest?"
>
> HAL replies, "The best thing would be to replace the unit with a spare so that we can check it over."[1]

In this example, the discourse between HAL and Dave is in no way perceptibly different from a conversation between two men. HAL and Dave effectively communicate information. The computer appears to understand Dave's inquiries, and Dave in turn appears to understand HAL's answers. (And, although it is not evident from the sample dialogue, the converse is also true — Dave can understand and answer HAL's requests.)

Actual dialogues between a machine and a person can also be indistinguishable from real conversation between people.

Analysis of an actual dialogue between a person with a computer program may provide some clues as to the mechanism of computer conversation. The program was written by Joseph Weizenbaum of M.I.T., and is named "Eliza" after George Bernard Shaw's character Eliza Dolittle (who is taught to speak correct English in the play *Pygmalion).* In the following sample, the program "talks" with a person who complains that "Men are all alike":

Person: Men are all alike.

Computer: In what way?

Person: They're always bugging us about something or other.

Computer: Can you think of a specific example?

Person: Well, my boyfriend made me come here.

Computer: Your boyfriend made you come here?

In spite of its simplistic mechanism, Eliza can be quite convincing in holding a conversation. As a therapist, Eliza is free "to assume the pose of knowing almost nothing of the real world."

Person: He says I'm depressed much of the time.

Computer: I am sorry to hear that you are depressed.

Person: It's true. I am unhappy.

Computer: Do you think that coming here will help you not to be unhappy?

Person: I need help, that much seems certain.

Computer: What would it mean to you if you got some help?

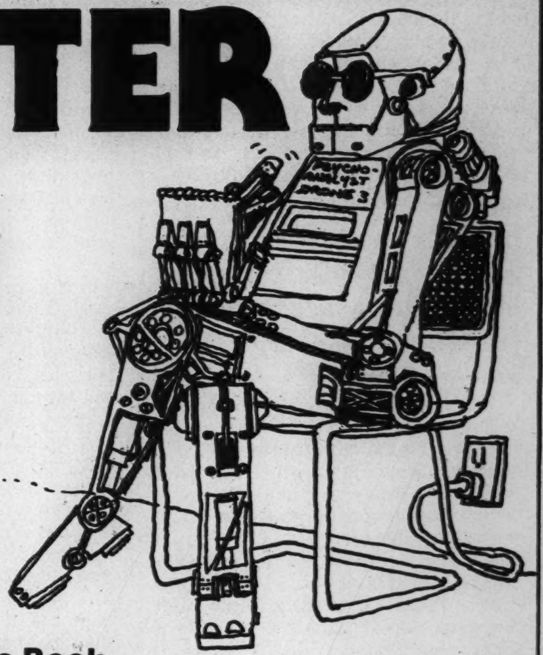
Person: Perhaps I could learn

---

*Go back one in the alphabet from each letter of IBM and you got HAL.

Robert Branchek, DEC, One Penn Plaza, New York, NY 10001.

MORE BASIC COMPUTER GAMES



Contents

Artillery-3
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Deepspace
Defuse
Dodgem
Doors
Drag
Dr. Z
Eliza
Father
Flip
Four In A Row
Geowar
Grand Prix
Guess-It
ICBM
Inkblot
Joust
Jumping Balls
Keno
L Game
Life Expectancy
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Dialogues, cont'd...

to get along with my mother.

Computer: Tell me more about your family.[2]

The difference between this dialogue and the one between Dave and HAL is that here the questions are typed on a typewriter-like device, a teleprinter, which inputs information to the computer, and the answers are returned on the same device. Eliza seemingly "understands" what is typed. Words are easily recognized by the computer, since they are merely unique sequences of symbols (which we call letters) set off by spaces.**

It finds a match in the word "alike." Its next instructions are to print "In what way?"

In the Eliza program, the computer retains a list of words of high information value, termed "keywords," and executes instructions which compare these keywords with each word in the typed-in sentence. For example, in the first sentence it compares all the words with its list until it finds a match. In our sample, it finds a match in the word "alike." Its next instructions are to print "In what way?" because it found a match for the appropriate keyword. The person who has selected the instructions — Joseph Weizenbaum — has of course assumed that "In what way?" will always be an acceptable response to a sentence in which "alike" appears. A further example of this mechanism is provided by the next sentence, "They're always bugging us about something or other," in which the instructions find a match for "always," whereupon the perfectly reasonable response "Can you think of a specific example?" is returned. The validity of the response once a keyword is found determines the effectiveness of the dialogue.

Instructions must be present which determine what to print when a keyword is not found, as well as when one is found. For example, in the third sentence, "Well, my boyfriend made me come home" it finds no keywords. Its instructions, when no keywords are found, are to print back the sentence with exclamations discarded (exclamations are defined as one or two words at the beginning of the sentence followed by a comma), the appropriate personal pronouns substituted, and a question mark replacing a period at the end. These instructions produce a response to the third sentence of "Your boyfriend made you come here?"

It is this simple matching and substitution process that produces, in response to the statement by the woman that she is depressed, the computer's statement, "I am sorry to hear that you are depressed." The instructions have found a match for "depressed," substituted *you* for *I*, added "I am sorry to hear that . . . ," and have discarded other unnecessary words to produce, "I am sorry to hear that you are depressed."

Additionally, Eliza's mechanism will return responses to any input sentence. Although it is not shown in the sample dialogue, when a keyword is not found in a sentence, Eliza must rely on generalized answers, such as "Tell me more" or "I see," which are acceptable answers to almost any input phrase.

Though Eliza usually returns appropriate responses, inappropriate ones can occur because of the simplicity of Eliza's mechanism. For example, if the woman in the sample dialogue had typed in the phrase, "My rock is depressed," Eliza's response would have been, "I am sorry to hear that your rock is depressed." Eliza doesn't really "consider" the meaning of more than one word in a sentence; hence, Eliza is unable to "recognize" that rocks don't get depressed, only people get depressed. All Eliza does is find certain words in a sentence or phrase, rearrange them, and print back an answer.

In spite of its simplistic mechanism, Eliza can be quite convincing in holding a conversation. According to Weizenbaum, however, this can be attributed to the mode of conversation. As a therapist, Eliza is free "to assume the pose of knowing almost nothing of the real world."[3] Its answers are only convincing in the restricted context of psychoanalysis, with Eliza serving in the role of a therapist — ignorant of the world, and able to respond only in terms that often function to solicit further responses from the speaker. Unlike the dialogue in *2001* between HAL and the astronaut Dave, no requests for concrete information can be answered by Eliza, or a program like it. Another mechanism must be used by a program if specific information is to be returned.

One of the first programs to use such a mechanism was developed at M.I.T. in 1960. Named "Baseball," it can be asked information about baseball games played in the American League, in one season of play. Baseball can return correct answers to questions such as, "Whom did the Red Sox lose to on July 5?" or, "How many games were played by the Yankees in the month of August?" Baseball could work as the ultimate commentary companion for a play-by-play radio announcer like Phil Rizzuto, the announcer for The New York Yankees, answering such complex questions as, "Did every team play at least once in each park in each month?"[4]

"Parry" functions as a patient — a paranoid — rather than a therapist. Its mechanism of understanding consists of several stages of processing.

The mechanism used by Baseball is essentially a large cross-referenced list containing the month, day, place, teams, and score of every baseball game played in one league, throughout an entire season. Unlike Eliza, Baseball can provide specific information in response to a request. However, it can only answer questions to which it has information — baseball in the American League for one specific year. So, like Eliza, its "world" is restricted. Its mechanism searches input requests for the keywords it can "understand," i.e., months, days, years, teams, runs, ballparks, and scores. Once the keyword in a sentence is found, it looks up the matching information contained in its list, and returns an answer. Its mechanism is not appreciably different from Eliza's, except that it can return specific information.

Another program, Student, provides a third example of a mechanism for carrying on an exchange of information. Student, developed by Brobrow at M.I.T. in 1964, can be asked to solve algebraic problems with a level of difficulty at approximately the high school level. For example, it can solve the following problems:

> If the number of customers Tom gets is twice the square of 20 percent of the number of advertisements he runs, and the number of advertisements he runs is 45, what is the number of customers Tom gets?
>
> Mary is twice as old as Ann was when Mary was as old as Ann is now. Mary is 24. How old is Ann?[5]

**Though it is possible to exchange information verbally with the computer by using an electronic voice and speech recognition unit, present man-machine dialogues are not usually conducted on auditory channels. This, however, is the only principal difference between actual computer conversations with men and fictitious ones. But since our interest in this discussion is not along which channel we can communicate, but in the underlying mechanism which makes communication possible, we may consider this difference superfluous.

Dialogues, cont'd...

The mechanism which Student uses to solve such problems is similar to those used by Eliza and Baseball: it looks for the keywords which it finds a match for in its list, and then replaces them, in order to solve the problem. However, unlike Eliza or Baseball, it substitutes variables, arithmetic operators, or constants for the keywords it finds. For example, the second problem is translated by substitutions into, "Mary's age is 2 times Ann's age K years ago; K years ago Mary's age was Ann's age now; Mary's age is 24, X is Ann's age." This is next translated, again by substitution, into the following set of equations:

$M=2(A-K)$
$M-k=A$
$M=24$
$X=A$

with M replacing Mary, A replacing Ann, and the expression $2(A-K)$ equaling Mary's age. Any related problems can be solved in the same way.[6]

Parry will also replace any letter with a letter that is near it on the keyboard of the teleprinter to correct errors like "dront" for "front."

The input to Student, like Baseball, contains a specific question, and a request for an answer, the solution to the problem. Unlike Baseball, requests made to Student contain the data, rather than the data being stored internally in the program. Student has only limited "knowledge," such as the number of the feet in a larger unit, the yard (a yard contains three feet), or basic relationships (like "distance equals velocity times time.")[7]

Mechanisms such as those used in Eliza, Baseball and Student would have difficulty with some requests because of two problems: the different meaning a word may have dependent upon its position in a group of words, and the different meaning a word may have independent of its sentence position. For example, if I pose the following question to Student — "If Veronica is taller than Susan and Susan is taller than Carol, what is the relationship between Veronica and Carol?" — Student can easily "recognize," or find a match for the key phrase, "taller than." It can then substitute a "greater than" symbol, >, which is used to represent a mathematical relationship which is written easily as a set of instructions. Student will also substitute variables for Veronica, Susan and Carol, forming an expression, "$A > B > C$", then, since the variables are ranked, it will also "recognize" that A must be greater than C. Student could then translate the variables A and C back to Veronica and Carol respectively, and the greater-than symbol back to taller than," and return the answer, "Veronica is taller than Carol."

However, a program like Student would have great difficulty with the following question, "If nothing is better than a good square meal, but a sandwich is better than nothing, what is the relationship between nothing and a sandwich, and nothing and nothing?" The phrase "is better than" can, like "is taller than," be replaced with the "greater than" symbol, and "nothing," "a good square meal," and a "sandwich" can all be replaced by variables. However, using the mechanism just described, Student will return to answer, "Nothing is better than a sandwich and nothing is better than nothing."

While some people may believe these assertions — those who like sandwiches and those who like nothing — such illogical or incorrect answers occur because of the meanings of the word "nothing" in the example. In its first context, "nothing" means "there isn't anything else that"; in its second usage means, "not anything else." Student does not contain the required instructions for dealing with the multiple meanings of a word, even when its meaning could be determined by its position in a sentence.

How difficult this problem can be is best illustrated by the sentence, "Time flies like an arrow," which can have at least four different meanings. Without changing the order of the words in the sentence, the following are four interpretations of what the sentence means:

1. Time moves in the same manner that an arrow moves.
2. Measure the speed of flies in the same way that you measure the speed of an arrow.
3. Measure the speed of the flies that resemble an arrow.
4. A particular variety of flies called "time flies" are fond of an arrow.[8]

An analysis of individual words in the different interpretations shows that time, in the first interpretation, can be understood as a noun; in the second and third interpretations, as a verb, to measure along the axis of time; and in the last interpretation, as part of a compound word "time flies" — seemingly a species of fly. The word "like" is used for comparisons meaning "in the same way" or "that resemble" in the first three interpretations, and means "caring for," or "fond of," in the last interpretation.[9]

Programs which "consider" the several possible meanings of a word in a sentence must use other sources of information to form an appropriate response. For example, a program's mechanism could use the group of words that surround a keyword to find its meaning. For example, in the sentence "John hit the ball with a bat," some words serve to explain how John, a ball, and a bat relate to the word hit. A program attempting to discover the meaning of the sentence, over and above merely the keywords, must "recognize" that John performs the action of hitting, that he does it to the ball, and that he uses the bat as a tool.[10]

"See red" is "understood" by Parry as identical in meaning to "become angry." "Emergency Room" is recognized as hospital."

A second way a program can ascertain the meaning of both a keyword and the major idea of the sentence is to look at the way each word is used in the sentence. The programmer, as the person who selects the instructions which determine how the mechanism of the program works, must first choose a group of words with similar characteristics, decide in what way they may be used for different meanings, and then locate other keywords which help to signal how the first word of a group of words is being used.

In the sentence, "John hit the ball with a bat," "John," "ball" and "bat" are all nouns. As in many sentences, the meaning of the sentence focuses around these nouns; the remaining words serve to show how "John," the "ball" and "bat" relate to one another. In this example, the word "with" indicates that the last noun, bat, is used as a tool by the noun that precedes it in the sentence, John.

In another example, "Mary went from the library to the bakery," the word "from" signals that the word "library" is used as an initial position, a place "from where" a noun which occurs earlier in the sentence, "Mary," is coming. The word "to" signals that the noun that follows it in the sentence, "bakery," is the destination where Mary will end up.

Dialogues, cont'd...

The word "for" in a sentence usually indicates a beneficiary — "for whom" some action is being performed, as in "Harold bought the lamp for Gertrude" or it can indicate duration, as in the sentence, "Louis had been at his desk for one hour." The word "by" can signal either the thing that causes the action to occur, for example, "Carol was kissed by Bob," or a container or means, as in "Herman always travels by train," or a location, as in "Jeffreys placed his shoes by his bed."[11]

Often, however, neither these words by themselves nor any reliable "signal" words are sufficient to resolve ambiguities in the meaning of the words in a sentence.

The first sentence typed, "Men are all alike," is answered by Eliza, "In what way?"

Ambiguity is particularly bad among verbs, the words that explain the type of activity occurring in a sentence. Fortunately, the position and the meaning of a noun tends to work together with the verb to resolve ambiguities about the meaning of each, even if "signal" words are absent. For example, in the sentence "Paul shot a picture," "picture" aids in determining the meaning of the action "shot" — presumably the tripping of the shutter of a camera; though it is possible but highly improbable that Paul shot a picture by pointing a gun at it and firing.

Other words can serve to define the meanings of words, such as verbs, in a sentence. In the sentence, "He threw away the food," the word "away" indicates that the food was discarded. This sentence has an entirely different meaning from the same sentence with "away" removed: "He threw the food," meaning he propelled the food through the air to an unspecified destination.[12]

A program can get other clues about word meaning from the position of the word in the sentence. Consider again "John hit the ball with the bat." A noun which occurs early in a sentence, like "John," frequently is used as the initiator of an action, while a noun which occurs later is frequently the recipient of the action, like "ball," or a tool, like "bat." While this is not always true, it can still help to assess the meaning of words in a relatively simple sentence.

Many combinations of words have unique meanings when they occur together, different from their meanings separately — in particular, idiomatic expressions like "eat up." Such expressions, recognized by a program, can help it "understand" the meaning of a phrase.

Using all these sources of information, it is possible to develop a more sophisticated mechanism than those used by Eliza, Baseball or Student for analyzing sentences. One of the best programs developed which can "understand" English text is a program called "Parry" which, unlike Eliza, functions as a patient — a paranoid — rather than a therapist. Its mechanism of understanding consists of several stages of processing, in which the input text is gradually transformed.

In the first stage of processing, all lower-case characters are converted to upper case because lower-case letters add little information value to the meaning of a word. In addition, other characters such as asterisks, which may have been inadvertently typed, are discarded. Finally, irregular spacing among words and punctuation is removed.[13]

In the second stage, each word is looked up in a dictionary list. If a match is found, Parry takes note of it for use in further processing phases, and continues to analyze the remaining words. If the word is not found, a second list of frequently misspelled words is consulted; if the word appears here, it is replaced by its correct spelling.

If the word is still not found, the trailing letters of the word (the last one, two, three, or four letters) are compared against a list of possible suffixes. Contractions are replaced by fully spelled-out words after comparison with a fourth dictionary list of words that accept contractions, e.g., don't, I'm, you're, etc. Suffixes which can change the meaning and function of a word are also analyzed. For example, the usual meaning and function of the words "agree" and "harmony" are "known" to the program. If the suffix "ize" is added to "harmony," an analysis shows that the resultant word "harmonize" now means "agree." A similar mechanism works with prefixes attached to words.[14]

If a word is not yet matched, it is now treated as a typing mistake. Parry will try several manipulations of the word to correct it and then run it through the list again. For example, Parry will selectively delete any double letter from a word to correct misspellings like "untill" for "until," and reanalyze the resulting word. Or it will transpose adjacent letters, to correct errors like "conceive" for "concieve." Parry will also replace any letter with a letter that is near it on the keyboard of the teleprinter — the device used to communicate with Parry — to correct errors like "dront" for "front." (The letter "d" and "f" are next to each other on the keyboard.) Finally, in a last attempt to correct misspellings, Parry will split a word into two words, trying all combinations of letters to correct for errors like "tothe" for "to the." If a word is not "recognized," it is deleted from the sentence.

Because computer programs run fast, all of these comparisons of words against one or more lists can be made rapidly. Successive phases of analysis of the text can also be done rapidly. Thus what would seem an impossibly tedious task for a person, the comparison of all the words of a sentence against several lists of words, is done easily by a program.

Parry contains a mechanism that uses not only the structure of input sentences but the meaning of most of the words of the sentence and often the meaning of the sentence itself.

The next step in the analysis performed by Parry is an attempt to deal with groups of words whose meanings cannot be determined by the individual words. These are the idiomatic expressions such as, "make up with," which is replaced by Parry with "reconcile with," or "see red," which is "understood" by Parry as identical in meaning to "become angry." Other idiomatic expressions such as "go to pieces," which is translated "to crumble," are also recognized as similar in meaning to words contained in one of Parry's lists.[15] Compound words, such as "Emergency Room," which is recognized as "hospital," are recognized and replaced in the same manner.

Words which act as verbs, i.e., words which indicate what type of action is occurring, are examined to find what tense they are in, i.e., when the action occurs. The program does this by looking at the endings of verbs, the last two or three characters.

Finally, the program determines how the meaning of the input sentence relates to its "world." In this respect, Parry is similar to the earlier programs. However, Parry will "recognize" questions that are outside of its world and will attempt to output answers that will return the topic of the conversation back to what it "understands." A sample of a dialogue with Parry should

Dialogues, cont'd...

serve to illustrate the result of its translation process. In the following sample, "I" labels the words of the person who is talking to the program and "P" labels the responses of Parry, the program:

I: What's your name?
P: Pat Smith.
I: Patrick or Patricia?
P: I'm a man. (Parry "recognizes" that Patrick is a male.)
I: How odl are yppu?
P: Twenty-eight. (Both misspellings are corrected.)
I: Why are you here?
P: I'm somewhat upset.
I: Have you dreamt any strange dreams?
P: I don't remember any dreams. (Parry "sees" the tense of the verb "dreamt" and changes it to a noun "dream" in forming a response.)

(Later in the dialogue)
I: Don't you like being here?
P: No. (Parry "understands" the reversal of the noun and verb in the question — forming an interrogative — and forms a correct response.)
I: Being in the hospital might do you a lot of good.
P: It's not helping me much to be here. (The idiomatic expression "do" — phrase with a noun — "good" is "understood.")

(Later in the dialogue)
I: Do you want to get a pair of socks for Christmas?
P: I want to be out of here. (Parry "recognizes" the meaning of the sentence as being out of its world and categorizes it as a frivolous question. Parry produces an answer which relates to its own world.)
I: Could you tell me the name of the first president of the United States?
P: Babe Ruth. (Parry again "recognizes" the question as being apart fron its world and, according to its instructions, returns a humorous answer).
I: When did you first learn that you were crazy?
P: I don't want to talk to you any more, buzz off.

(Parry responds to the keyword "crazy" in producing this response.)

(Later in the dialogue)
I: What are you going to be doing at the same time of day tomorrow?
P: I'll be here on the ward. (It "understands" the complex verb phrase and forms its response.)
I: Bye, Pat.
P: Goodbye.[16]

In a comparison of Parry with Eliza, Baseball and Student, Parry is easily the best example of a program that "understands" sentences and phrases. Parry contains a mechanism that uses not only the structure of input sentences but the meaning of most of the words of the sentence and often the meaning of the sentence itself. Clearly, Parry comes closest to the idealized fictitious dialogue between a person and a computer, Dave and HAL respectively, in *2001*.

Parry will "understand" only information about its own "world" and very little about anything else.

The mechanisms of the programs Eliza, Baseball and Student are based predominantly on the syntax of the English language and the meaning of one keyword per input. Although these programs can seemingly carry on a conversation, none can do so as effectively as Parry. Eliza will not answer requests for concrete information; and although Baseball and Student answer such requests, their mechanisms do not allow for the varied responses returned by Parry. Not unexpectedly, Parry is the most recently written of the four programs, and represents the present state of development for mechanisms producing man-machine dialogues.

Although the mechanism used by Parry seems complicated when compared with the mechanisms of Eliza, Baseball or Student, it is still limited. Parry will "understand" only information about its own "world" and very little about anything else. This should not suggest, however, that more complicated mechanisms cannot be developed in the future. Samuel Butler, in the nineteenth century, recognized this when he wrote, "There is no security against the ultimate development of mechanical consciousness in the fact of machines possessing little consciousness now."[17] Indeed, even now, dialogues between men and computers are, in many instances and respects, not recognizably different from dialogues between people. ☐

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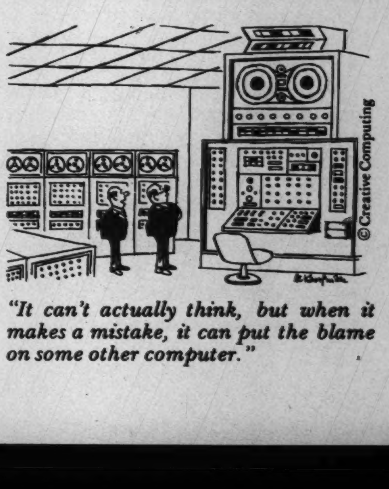

"It can't actually think, but when it makes a mistake, it can put the blame on some other computer."

Flying Beyond the Thought Barrier

The Psychic Boom

Hubert L. Dreyfus
and
Stuart E. Dreyfus

> A senior scientist [recently] noted that technology was passing man by. The operator could no longer process and input information fast enough to keep up with his onboard central processors... He could not react at the rates required by his systems.[1]

> I ask students to stand at net in the volley position, and then set the machine to shoot balls at three-quarter speed... At first the balls seem too fast for them, but soon their responses quicken. Gradually I turn the machine to faster and faster speeds, and the volleyers become more concentrated. When they are responding quickly enough to hit the top-speed balls and believe they are at the peak of their concentration, I move the machine to midcourt, fifteen feet closer than before. At this point students will often lose some concentration as a degree of fear intrudes. "Relax your mind... Let it happen." Soon they are again able to meet the ball in front of them with the center of their rackets. There is no smile of self-satisfaction, merely total absorption in each moment. Afterward some players say that the ball seemed to slow down; others remark how weird it is to hit balls when you don't have time to think about it.[2]

While man's technology, it seems, may be overtaking his capacity to *think*, it may not yet have even approached a skilled performer's ability to *act*. Such action faster than thought is not only a necessity when dealing with high-technology systems but even when there is time for thought the ultimate level of master performance is reached only by quieting the analytical mind.

This highest level of performance is reached by passing through a series of quite distinct stages.[‡] The novice jet pilot focuses all attention on a list of memorized procedures to be applied in terms of specific context-free features which could be recognized by any objective observer. In doing so, he is so absorbed in details that he is unaware of surrounding events, and he experiences no sense of flying.

Courtesy of McDonnell Douglas

With further experience the trainee acquires the ability to recognize such situations as being in the landing envelope and such sensations as the accelerational forces, characteristic sounds and vibrations and learns their importance. He analytically determines his actions by applying maxims such as "determine whether the aircraft is in the landing envelope,"[4] return to base when vibrations are abnormal, etc. This intermediate student pilot begins to feel that he is flying the plane.

Finally, a pilot's repertoire of flying experiences becomes so extensive that each whole current situation is recognized as similar to a previous typical situation (paradigm);[‡‡] and this previous situation elicits a remembered appropriate response. Furthermore, associated with each of these paradigms are other paradigms. Each of these associated paradigms are ones to which the original situation might typically be seen as similar should the salient aspects of the current situation not be what the current paradigm would lead one to expect. For example, suppose that the current situation is a normal landing, and hence location in the center of the landing envelope is a crucial aspect. If the pilot perceives that he is very high in the landing envelope, the associated paradigm in terms of which he might see himself is a "go around" situation. The analytic mind has been completely bypassed in the production of performance and replaced by a holistic and intuitive mode of response. The pilot now has the experience that he is flying.

The same tri-partite phenomenon shows up whenever a person acquires a complex skill, be it highly intellectual like chess, or largely physical like tennis. For example, in chess a beginner learns simple rules involving context-free features, such as to trade pieces so as to maximize material balance (calculated by adding up the values of the individual pieces involved). In tennis, a player first learns context-free movements such as transferring his weight from one foot to the other while making a stroke.

With experience, a chess player learns to follow maxims such as "exploit a weakness on the king's side" or "avoid an unbalanced pawn structure." (There are, of course, no objective rules by means of which a novice could determine whether the pawn structure was unbalanced or the king's side weak.) And in tennis an experienced player may be advised to use top-spin on his lob.

When truly proficient, a chess master, immersed in the world of the game, immediately perceives the forces and tensions on the board as

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Psychic, cont'd...

similar to those previously experienced in actual play or in the involved study of previous games. The highly skilled tennis player no longer thinks about using top-spin or applying other maxims, but, by-passing his analytical mind, he enters into the rhythm of the game.[6]

We're interested here in the various roles that the analytical mind, once it has been by-passed in the production of performance, can take vis-a-vis highly proficient activity.

In order to perfect the intuitive mind's paradigms, and in some cases even to improve its current performance, the analytical mind can review and improve the two associative functions of the paradigms. At the simplest level, it can assess how well the action associated with each paradigm enables the proficient performer to cope with each situation. For example, during air-to-air combat a highly proficient pilot's analytical mind might be assessing the appropriateness of maneuvers. If the analytical mind senses that the instantaneous intuitive responses are indeed appropriate, the pilot feels with euphoria that he is ahead of the plane. If inappropriate, there is uneasiness and the pilot feels that he is lagging behind the plane.[7]

In this latter case, the analytical mind shifts to monitoring the second associative function of paradigms. Assuming an experienced performer with an adequate repertoire of appropriate paradigms, one reason a whole sequence of actions based on a series of paradigms can fail to cope adequately is that the associative function which replaces one paradigm by another when the former ceases to be appropriate needs improvement. Presumably, the intuitive mind, in moving from paradigm to paradigm, has gone down a path of association which has led to a current paradigm with an inappropriate associated action.

Courtesy of McDonnell Douglas

The intuitive mind is "locked into the wrong Gestalt." The job of the analytical mind is to get it out, and also to prevent this happening again.

Courtesy of General Dynamics

To see what the analytical mind can do to get the intuitive mind back on the track, consider the following. If the intuitive mind is seeing the Necker cube in Figure 1 as a cube with vertex A in the nearest face and vertex B in the farthest face, the analytical mind can sometimes reverse the cube by focusing on vertex B. This makes vertex B salient, and the intuitive mind, if it is not hopelessly locked in the old Gestalt, will move the farthest face to the foreground, and the cube will reverse.

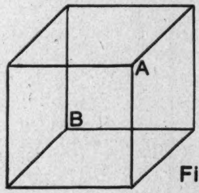

Figure 1

In general, when the intuitive mind is perseverating in what might be an inappropriate set, the analytical mind can focus its attention on aspects of the current situation which are inessential viewed under the current paradigm. The intuitive mind can then either ignore these aspects or it can see the situation in terms of a different paradigm in which these aspects are crucial. Thus a pilot, in air-to-air combat with an adversary whom he deems to be of equal experience, may, after experiencing a sequence of actions as inappropriate, analytically entertain the hypothesis that his adversary is much less experienced than he supposed, and thus focus on aspects of the engagement he had not previously noticed. This may cause him to see events in a different light, and if his actions become more appropriate he will have learned to respond to such a possibility the next time he encounters a similar situation.

We have seen that there are two important types of *monitoring* functions performed by the analytical mind while the intuitive mind is engaged in the production of skilled performance: it can monitor the appropriateness of the actions to the situation and thereby improve performance in the future, or it can monitor the overall sense of the situation produced by the sequence of paradigms guiding the intuitive mind and can focus on aspects that the current paradigms lead the performer to overlook. We shall now see that the analytical mind can function in two other *nonmonitoring* modes. First, and most obviously, when the intuitive mind has completely taken over current skilled performance, the analytical mind is freed to engage in other tasks. Experienced drivers easily carry on conversations while still performing proficiently. In this mode there is probably no learning from experience, and whenever the unexpected occurs, one stops the unrelated analytical activity and focuses the entire mind upon the current situation. Second, masters of all skills experience moments of intense involvement during which the analytical mind is completely quiet. There is no awareness of the passage of time and only after these moments are passed is there awareness of what has taken place. ‡‡‡ This unselfconscious concentration occurs during moments of masterful intellectual activity ‡‡‡‡ and moments of peak performance of highly trained motor skills. No mental energy is allocated to monitoring. It is during these episodes that action is faster than thought.

These bursts of masterful performance at speeds faster than thought are not achieved without risk. To concentrate all of one's resources on performance one has to relinquish the monitoring function of the analytical mind, and thus run the risk of overlooking the true sense of the situation and blindly, albeit brilliantly, pursuing an inappropriate sequence of actions. ‡‡‡‡‡ In spite of the risk, pilots of the latest high-technology systems must be encouraged to cultivate this spontaneous mode of response. They must learn that in moments of crisis the analytical

Courtesy of Grumman Aerospace Corp., Bethpage, NY

Psychic, cont'd...

process that in general permits learning and avoids mistakes must be transcended. For the very highest performance, they must unlearn the learning habits which first made their acquisition of proficiency possible. ☐

Courtesy of Grumman Aerospace Corp.,

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Footnotes

‡ We have distinguished these stages in more detail and argued for their psychological reality in another paper.[3]

‡‡ Psychologist Lee Brooks has experimentally shown that in certain situations subjects do, indeed, recognize patterns as similar to specific individual cases rather than as instances of a class defined in terms of necessary and sufficient features.[5]

‡‡‡ This phenomenon, according to Colonel Evan J. Griffith, occurs during crucial moments of air-to-air combat.

Courtesy of General Dynamics

‡‡‡‡ We do not mean, here, moments of creativity. We have no explanation of this ability to transcend all past experience.

‡‡‡‡‡ A pilot faced with a sudden emergency should first respond instinctively and virtually instantaneously, but if this burst of unmonitored activity fails to cope with the crisis the analytical mind must intervene to question the pilot's original intuitive sense of the situation. If by calling attention to overlooked aspects the analytical mind can summon up a more appropriate paradigm, action faster than thought may again be possible. But if no paradigm is found, the analytical mind must take over the production of performance and use whatever propositional knowledge is relevant. Two recent examples of last-recourse analytical brilliance by commercial pilots are: (1) Jack McMahan's use of the unusual downward pitch known to be produced by the rear engine of a Lockheed 1011 to compensate for a system failure leading to uncontrollable climb[8] and (2) Harvey Gibson's use of the landing gear to slow the almost supersonic speed of a diving Boeing 727.[9]

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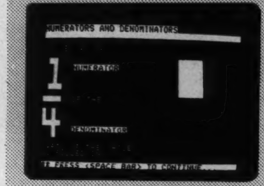

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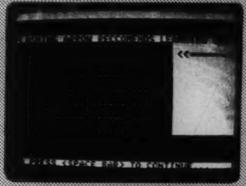

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A New Computer Language for the Legal Profession

ABF

Bob McCray

Lawyers, long symbolized by the quill and scroll, may soon be in for a new image if a new computer language recently introduced proves successful. And, if so, it could one day be that the computer may be as common in the law office as Black's Law Dictionary.

The computer language, called ABF (American Bar Foundation) was developed at the Vogelback Computer Center at Northwestern University in Evanston, Illinois, under the sponsorship of the American Bar Association. It was first introduced in February, 1978, at the American Bar Association Semiannual meeting.

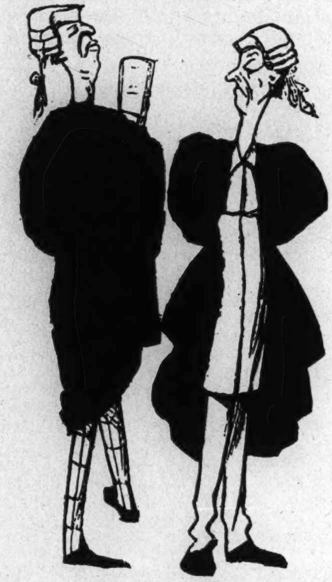
Computers have, of course, been used for some time by law firms for a number of purposes, such as billing and legal research. However, the new language may allow the general lawyer to use the computer in his day-to-day practice.

Jim Sprowl, patent attorney and electrical engineer, who helped develop the system, explains that ABF may enable general lawyers to use legal computer programs that are set up by the legal specialist, allowing the lawyer to possibly handle more types and a higher volume of cases.

Sprowl, who teaches "Computers and the Law" at Northwestern University and IIT/Chicago-Kent Law schools, and has written the book, **A Manual For Computer-Assisted Legal Research,** recently published an article explaining the ABF language in the American Bar Foundation Research Journal, entitled "Automating The Legal Reasoning Process: A Computer That Uses Regulations and Statutes to Draft Legal Documents." Since October, 1978, the ABF Computer Law System has been in operation on an experimental basis at the IIT/Chicago-Kent Law School Legal Services Center, using the full resources of a Control Data Computer under the direction of Law Professor Gary Laser.

Law Professor Gary Laser (right), Director of the IIT/Chicago-Kent Law School Legal Services Center, assists a legal assistant with the ABF Computer law system as Jim Sprowl (standing, center) explains a legal document produced by the system.

The IIT/Chicago-Kent legal center is set up much along the lines of a teaching hospital in the medical field. Staffed by ten full-time practicing lawyer/professors, the center provides service, education and research. The computer/law project is part of the research function of the clinic. After an experimental period the center expects to fully incorporate the computer project into its education and service functions.



Presently, two ABF computer law systems are in operation. Both were developed by clinical professors. An estate planning system processes 20 to 30 wills a month. With each case client information sheets are processed into the computer by a lawyer or trained intern, who executes commands, and receives a will as a printout ready for editing.

A second computer law system in operation processes all the forms necessary for uncontested Guardianship (of the person) cases. Because of a need in the Chicago area, several public service organizations requested the clinic to devise an efficient, low-cost system for handling a large volume of cases. Professor Laser anticipates processing up to 50 to 100 Guardianship cases in a single month.

Lawyers, long symbolized by the quill and scroll, may soon be in for a new image.

Two other systems will soon be operating. A divorce system, being designed by Clinical Professor Carolyn Hughes, will involve interviews and interface with the computer at three stages during the legal proceedings — the complaint, trial and decree.

Bob McCray, 827 Lincoln, Evanston, IL 60201.

Then to evaluate the experiment, Professor Ronald Staudt, Associate Director of the Legal Services Center, and a programmer at the Vogelback Computer Center in Evanston, are designing a time-accounting case management system. This should be in operation in a short time.

According to Professor Laser, it is too soon to predict how cost-efficient each of the systems will be. He says that the lawyers presently working with the system are enthusiastic about the possibilities, and view the computer as playing a role in the future, but in some instances believe the time investment required of the lawyer to learn the processor may be a drawback.

The new language may allow the general lawyer to use the computer in his day-to-day practice.

Ideally, however, Professor Laser maintains that when the ABF system is finally completed, a lawyer should be able to learn how to execute commands and work with the processor (where the computer delivery system is programmed already) in as little as two and one-half days. For the lawyers to learn how to program the documents onto the system would take significantly more training and continuous use.

Professor Laser feels that if the computer/law project experiment proves successful, both lawyers and clients could benefit. He adds that, although the present computer/law study has not been evaluated, he holds a personal opinion about computers formed from his experience in learning the power of the computer and from witnessing the rapid acceleration of new technology. In his personal opinion he estimates that within the next three or four years this kind of a system could dramatically lower the cost of legal services while at the same time improving quality. ☐

The Computer Store of the Month

the computer corner

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In the late 60's and early 70's, a few forward-thinking people had the idea that public access to computers was a Good Idea. But computers were expensive and only a few of these projects got off the ground. Some notable ones were Bob Albrecht's People Computer Company in Menlo Park, CA; the Boston Children's Museum program run by Bill Mayhew and the Wang 2200B in White Plains Public Library. The moving spirits behind this last one were Hal and Harriet Shair. Hal was then employed at Consumer's Union. (See Creative Computing, Vol. 3 No. 3, pg. 36-38).

Then in 1976, Harriet Shair decided that it was time for a change from her teaching career. Altair and IMSAI had just announced their computers so it seemed like a ripe time to carry this public access idea one step further and open a small store in White Plains Mall.

The store has expanded four times since then and is the oldest continuously operating store in New York. Hal joined Harriet in the store in 1979.

In response to the growing needs of its community, the Computer Corner offers intensive seminars like "Basic Programming" in its seminar rooms. For small businessmen, a course in the business applications of the Apple computer is offered. The Computer Corner stocks vast amounts of software, books and magazines and supports the Apple, PET, North Star, Hewlett-Packard and Dynabyte. The store is a complete service center which sells components, interface boards, mainframes and comprehensive business systems.

The Computer Corner stocks Creative Computing Magazine, Press Books and Software. It is located in the White Plains Mall, 200 Hamilton Avenue, White Plains, New York 10601. Hours are Monday-Saturday 10-6; and Thursdays 10-9 PM. The telephone number is *914-WHY-DATA.*

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A Consistently Well-Behaved Method of Interpolation

Russell W. Stineman

We're not an academic journal, but once in a while something serious and original comes in. This is apparently a real solution to a problem graphics guys know well; this paper gives a smooth slope-matching interpolating curve, without ever going wild.

Abstract

When a curve is represented in a digital computer by a table of points, many methods of interpolation have difficulty near an abrupt change in the slope of the original curve. The problem is evidenced by the interpolating curve having more inflection points than the actual function that it is intended to approximate.

Polynomial interpolation often gives wild results near an abrupt change of slope.

This paper presents a method of interpolation which generates a curve that will never have more inflection points than are clearly required by the given set of points. The interpolating curve passes through the tabulated points and exactly matches the given slopes at those points (except for one unlikely degenerate case which has a slope discontinuity at one of the given points).

When used to approximate a sine function, the method of this paper was found to be more accurate than spline interpolation. The amount of computation required to find an interpolated point is approximately the same as to evaluate a sixth-degree polynomial.

An appendix presents a suggested way to compute slopes at the given points when only the points are known. However, exact slopes should be used whenever possible.

Russell W. Stineman, Boeing Aerospace Company, P.O. Box 3999, Seattle, WA 98124.

Introduction

In digital computer computations, it is common to represent a curve by a set of points, with interpolation between points. However, as is well known, polynomial interpolation often gives wild results near an abrupt change of slope. Spline interpolation can also give unreasonable results.

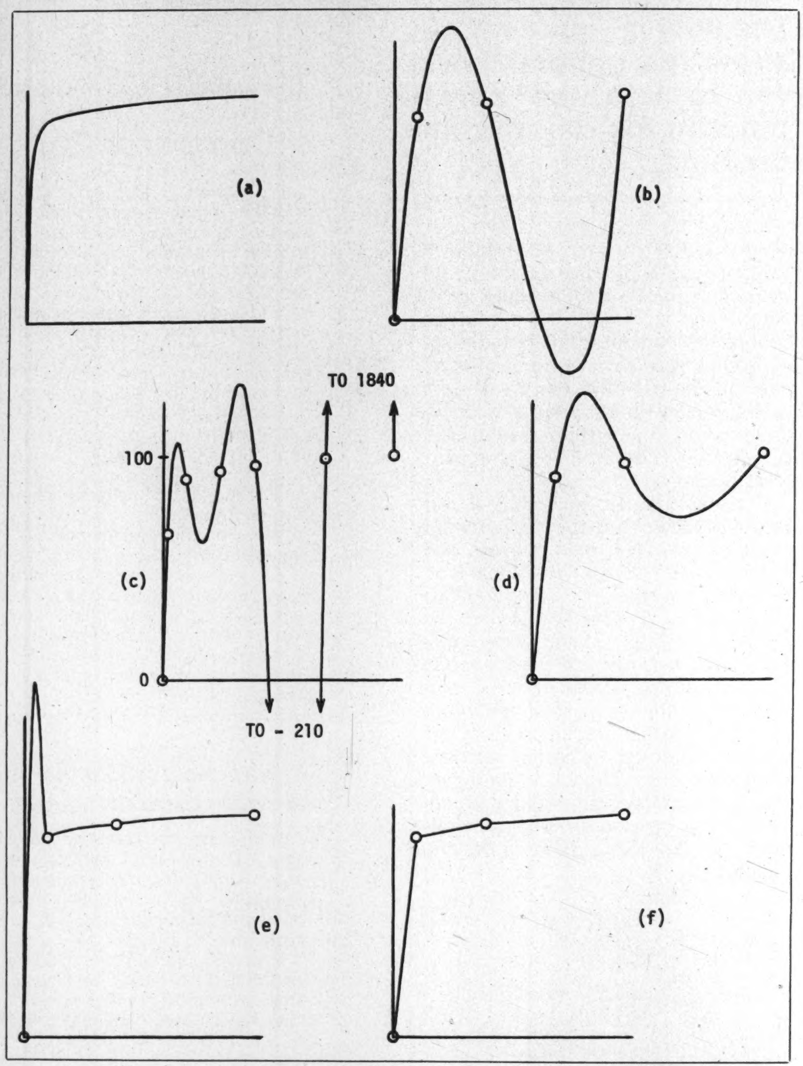

Figure 1

The problem is illustrated in Figure 1. Curve (a) shows a monotonically increasing curve with an abrupt decrease in slope. In (b), four points on curve (a) have been fitted by a cubic polynomial, with completely unsatisfactory results. In (c), three additional points have been taken from (a) and all seven points have been fitted by a 6th-degree polynomial, still with unsatisfactory results. In (d), the same four points as in (b) have been fitted by three piecewise cubic polynomials, chosen to preserve continuity of first and second derivatives at the interior points ("spline" interpolation), again unsatisfactory. Piecewise cubics are also used in (e), but the slopes at the given points are made equal to the slopes in (a), also unsatisfactory. In desperation, many analysts have used linear interpolation as in (f), accepting the need for a relatively large number of points to achieve a given accuracy.

The complete assurance that the procedure will never generate "wild" points makes it attractive as a general-purpose procedure.

What is needed is an interpolation procedure with the following properties:

a. If values of the ordinates of the specified points change monotonically, and the slopes of the line segments joining the points change monotonically, then the interpolating curve and its slope will change monotonically.

b. If the slopes of the line segments joining the specified points change monotonically, then the slope of the interpolating curve will change monotonically.

c. Suppose that the conditions in (a) or (b) are satisfied by a set of points, but a small change in the ordinate or slope at one of the points will result in conditions (a) or (b) being no longer satisfied. Then making this small change in the ordinate or slope at a point will cause no more than a small change in the interpolating curve.

An interpolation procedure that has the above properties is given in the next section of this article. The last of the three properties is discussed later in the paper in terms of an example.

Interpolation Procedure

In the following discussion, it is assumed that x_j, y_j, y'_j, j = 1, 2,..., n are given where

x_j, y_j = rectangular coordinates of jth point on curve.

y'_j = slope of the curve at jth point.

$x_j < x_{j+1}$ for j = 1, 2,..., n−1

If the slopes are not initially known, they may be calculated by the method described in the Appendix. Slopes thus calculated are consistent with achieving the objectives stated in the Introduction.

Given x such that $x_j \le x \le x_{j+1}$, the procedure for calculating y (the corresponding interpolated value) is the following. The slope of the line segment joining the two points is

$$s_j = \frac{y_{j+1} - y_j}{x_{j+1} - x_j} \qquad (1)$$

Values of s_j may be precomputed and stored along with the given points and slopes. On the line segment, the ordinate corresponding to x is

$$y_o = y_j + s_j (x - x_j) \qquad (2)$$

Next,

$$\Delta y_j = y_j + y'_j (x - x_j) - y_o \qquad (3)$$

where Δy_j is the vertical distance from the point (x, y_o) to a line through (x_j, y_j) with slope y'_j, as shown in Figure 2. Similarly,

$$\Delta y_{j+1} = y_{j+1} + y'_{j+1} (x - x_{j+1}) - y_o \qquad (4)$$

is the vertical distance from the point (x,y_o) to a line thru (x_{j+1},y_{j+1}) with slope y'_{j+1}, also shown in Figure 2. The product $\Delta y_j \; \Delta y_{j+1}$ is then calculated and tested.

If $y'_j = s_j$, then the line through point (x_j, y_j) with slope y'_j will coincide with the line segment joining points (x_j, y_j) and (x_{j+1},y_{j+1}), and $\Delta y_j = 0$. Similarly, if $y'_{j+1} = s_j$, then $\Delta y_{j+1} = 0$. If either or both Δy_j and Δy_{j+1} are zero, then the product $\Delta y_j \; \Delta y_{j+1} = 0$, and y is simply

$$y = y_o \qquad (5)$$

If $\Delta y_j \; \Delta y_{j+1} = 0$, but Δy_j and Δy_{j+1} are not both zero, then the interpolating curve will have a slope discontinuity. For example, if $\Delta y_j \neq 0$, then the slope for $x_j < x < x_{j+1}$ will be $y' = s_j = y'_{j+1}$. But as $x \rightarrow x_j$ from the left, $y' \rightarrow y'_j \neq s_j$. This degenerate case is the only way a slope discontinuity can occur.

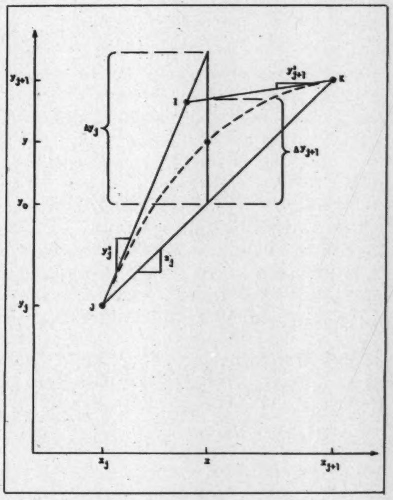

Figure 2

If $\Delta y_j \; \Delta y_{j+1} > 0$, then (as in Figure 2) Δy and Δy_{j+1} have the same sign, and

$$y = y_o + \frac{\Delta y_j \; \Delta y_{j+1}}{\Delta y_j + \Delta y_{j+1}} \qquad (6)$$

Equation (6) always determines the point (x,y) inside the triangle IJK of Figure 2. The slope of the interpolating curve matches the given slopes at the given points. The slope changes monotonically between the given points, so the interpolating curve is always concave toward the line segment joining the given points.

If $\Delta y_j \; \Delta y_{j+1} < 0$, then the geometry is like Figure 3, and there must be an inflection point between x_j and x_{j+1}. In this case,

$$y = y_o + \frac{\Delta y_j \; \Delta y_{j+1} \, (x - x_j + x - x_{j+1})}{(\Delta y_j - \Delta y_{j+1}) \, (x_{j+1} - x_j)} \qquad (7)$$

Equation (7) always determines the point (x,y) inside the quadrilateral JIKL of Figure 3, where the vertical distance LO equals the vertical distance OI. The slope of the interpolating curve matches the given slopes at the given points. The interpolating curve intersects line segment JK at its midpoint.

The rationale for equation (7) may be understood by considering the case where y'_j is significantly greater than s_j, the slope of line segment JK, but y_{j+1} is nearly equal to s_j, Figure 2 or 3. Regardless of whether y_{j+1} is greater or less than s_j, points I and L will be very close to point J and the interpolating curve will be very close to line segment JK. Thus, a change of y_{j+1} from slightly more than s_j to slightly less than s_j will cause only a slight change in the interpolating curve. This example illustrates the third requirement given in the Introduction.

Equations (6) and (7) fall in the general area of rational interpolation. However, the desirable properties of this method of interpolation stem from the particular form of (6) and (7). In general, rational interpolation does not have such properties.

The curve in Figure 1(a) was calculated by the above method of interpolation, given the four points shown in Figure 1(b), and with slopes calculated by the method given in the Appendix.

Accuracy

The accuracy of the given interpolation procedure may be illustrated

Interpolation, cont'd...

by fitting the function

$$y = \sin x \qquad (8)$$

No attempt is made to get an optimum fit. Rather, the values chosen for x_j are 0, 45, and 90 degrees, and the corresponding values of y_j and y'_j are computed exactly using equation (8). The resulting interpolated curve deviates from sin x by a maximum of .00333, at x = 24 degrees.

By contrast, the maximum error using linear interpolation is .0704, at 68 degrees. From another standpoint, to achieve a maximum error of no more than .00333, linear interpolation requires that x be given at intervals of 9 degrees.

An example given in reference [1] considers one full cycle of the function given in equation (8). The points x_j are selected at 45-degree intervals (that is, x_j = 0, 45, 90,..., 360 degrees), and the values of y_j are calculated exactly by (8). Interpolation is then done with a fifth-degree spline. That is, piecewise fifth-degree polynomials are found such that the interpolating curve and its first four derivatives are continuous. The interpolating curve also exactly matches the first and third derivatives of equation (8) at x = 0 and at x = 360 degrees. The interpolating curve deviates from sin x by a maximum of .0372, at 25 and at 335 degrees.

The same 9 points as in the above example from reference (1) were fitted by the method of this paper, using slopes calculated by the method given in the Appendix, rather than exact slopes. In this case, the interpolating curve deviates from sin x by a maximum of .0766, at 18 and at 342 degrees. Using exact slopes, the maximum error is .00333, at 24, 156, 204, and336 degrees. This shows the importance of using accurate slopes at the given points, if the slopes are known.

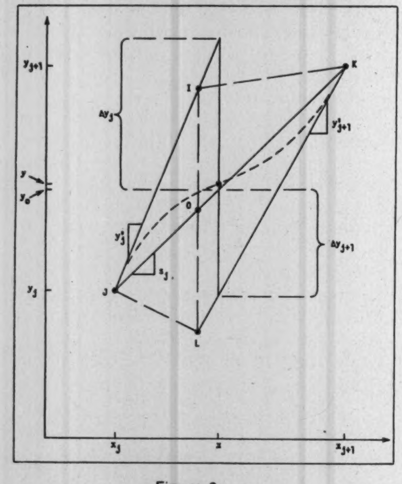

Figure 3

Conclusions

A procedure has been presented for interpolating between tabulated points. This procedure completely avoids the problems which various forms of polynomial interpolation, including spline interpolation, have near an abrupt change of slope. The procedure is especially recommended for such applications as the voltage-current curve of a semiconductor. However, the complete assurance that the procedure will never generate "wild" points makes it attractive as a general-purpose procedure.

The procedure uses only ordinary arithmetic operations (that is, no trigonometric, exponential, or similar functions need be evaluated. The number of operations is approximately equivalent to the evaluation of a sixth-degree polynomial. Memory required for data is four words per point.

In desperation, many analysts have used linear interpolation, accepting the need for a relatively large number of points to achieve a given accuracy.

When fitting a known function, the procedure given in this paper is at least as accurate as spline interpolation, provided that accurate values are available for the slopes of the function at the given points. For a given accuracy, the spacing of tabulated points may be significantly greater than for linear interpolation.

Appendix. Calculation of Slopes

Given the points x_j, y_j, j = 1, 2,..., n, the problem addressed in this Appendix is to compute slopes, y'_j, consistent with the requirements stated in the Introduction. It is assumed that the interpolating procedure given in this paper will be used.

In Figure 4, let I, J, and K be any three consecutive points. Point J may be above or below the line segment joining I and K, as shown in Figures 4(a) and 4(b), respectively. The requirements of the Introduction are satisfied if y'_j has a value between the slopes of the line segments IJ and JK. That is, for Figure 4(a), it is necessary that

$$\text{slope (IJ)} > y'_j > \text{slope (JK)} \qquad (9a)$$

while for Figure 4(b),

$$\text{slope (IJ)} < y'_j < \text{slope (JK)} \qquad (9b)$$

Another point is that if, for example, line segment IJ is much shorter than JK, it may easily be seen that a smoother overall interpolating curve will result if y'_j is nearly equal to the slope of IJ.

All of the above considerations are satisfied by setting y_j equal to the slope at point J of a circle through points I, J, and K. Thus

$$y'_j = \frac{(y_j-y_i)\ ((x_k-x_j)^2 + (y_k-y_j)^2)\ +}{(x_j-x_i)\ ((x_k-x_j)^2 + (y_k-y_j)^2)\ +}$$

$$\frac{(y_k-y_j)\ ((x_j-x_i)^2 + (y_j-y_i)^2)}{(x_k-x_j)\ ((x_j-x_i)^2 + (y_j-y_i)^2)} \qquad (10)$$

Equation (10) takes care of all interior points. The end points require special attention. From the requirements of the Introduction, it may be seen that the slope at an end point must have the same sign as the line segment from the end point to the next point. In line with the use of equation (10), one might try drawing a circle through the first (or last) three points. However, if either point I or K of Figure 4 is an end point, the particular arrangement of the points causes the slope of the circle at I or K to have the wrong sign. The sign of the slope is not necessarily wrong at the end point, but it may be wrong.

The problem divides into two cases. To simplify the notation, let M and subscript m designate either point I or point K, whichever is an end point, and let s be the slope of the line segment joining points J and M. The first case occurs when s is "steeper" than y'_j. In this case, a parabola through

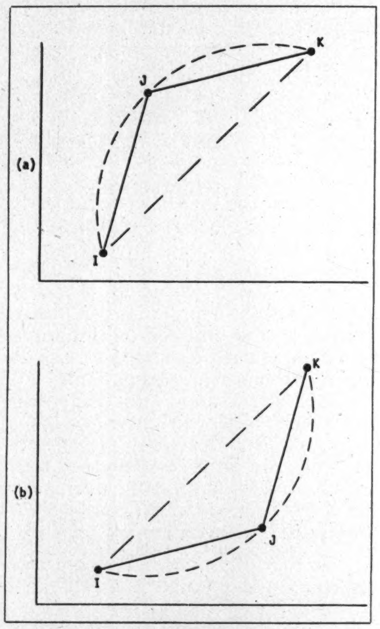

Figure 4

J and M with slope y'_j at J has a slope at M which meets the requirements and is reasonable. Stated more precisely, if $s > 0$ and $s > y'_j$, or if $s < 0$ and $s < y'_j$, then

$$y'_m = s + (s - y'_j) = 2s - y'_j \quad (11a)$$

The second case occurs if neither condition for the first case is satisfied.

The procedure uses only ordinary arithmetic operations. The number of operations is approximately equivalent to the evaluation of a sixth-degree polynomial. Memory required for data is four words per point.

In this case, the term in parenthesis in equation (11a) is multiplied by a factor between zero and one which assures that y'_m is always the same sign as s. The result is

$$y'_m = s + \frac{|s|\,(s-y'_j)}{|s| + |s-y'_j|} \quad (11b)$$

It should be understood that the slopes calculated by equations (10) and (11) are not independent of the scaling of the variables. For best results, x and y should be scaled to have roughly equal ranges, before calculating slopes. ☐

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* * *

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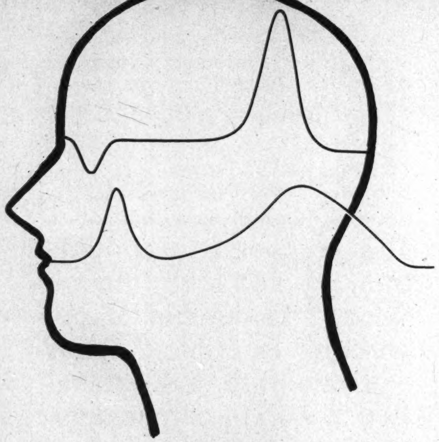
Fast Fourier Transform Fundamentals & Applications



Phillip L. Emerson, Ph.D.

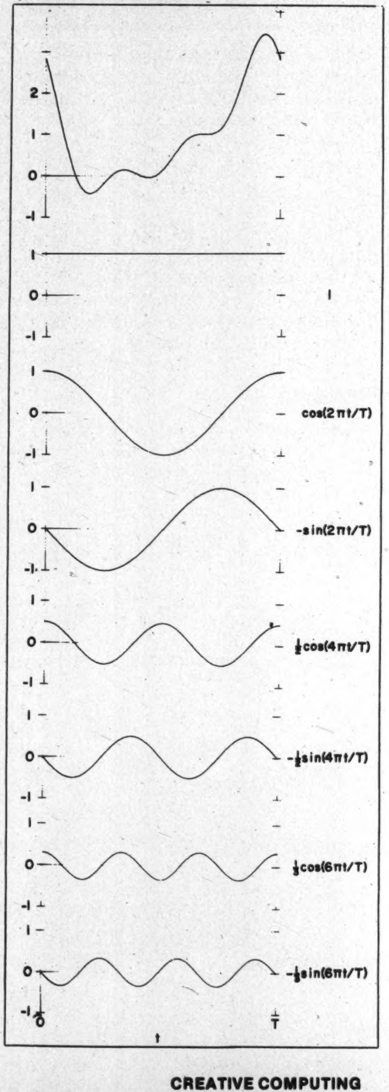
The Fast Fourier transform can be used to understand much more than acoustical tones and carrier waves. The FFT allows you to study both periodic and aperiodic events of all kind.

If you have been intimidated by long, uninteresting assembly listings for the Fast Fourier Transform (FFT); if the FFT really is not very important to you; if you have only occasionally wished you had an FFT program; if the FFT will not substantially increase your income; if it is not one of your main goals in life; if your first reaction is "Why bother?" then this article is written for you. Read on. From the accompanying flow charts, even the most apathetic programmer will finish coding the FFT before running out of enthusiasm. Almost any computer will do, and any of the common languages can be used: Basic, Focal, APL, Fortran, assembly language, or whatever. It is easily done with standard hardware, but there are ample opportunities to exploit special gadgets such as PROM, floating-arithmetic modules, etc.

What can you do with the FFT? You can get acquainted with it. You can demonstrate it to your friends and neighbors.

What can you do with the FFT? You can get acquainted with it. You can demonstrate it to your friends and neighbors. You can criticize it. You can try to beat it. You can monkey with it to make it run faster or occupy less memory. It accepts an input sequence of samples of a signal, equally spaced in time (or some other dimension, if you have imagination), and performs a discrete Fourier transform on the sequence. For example, the output gives an estimate of how much each frequency component contributes, in a periodic signal, for the first N/2 harmonic frequencies, where N is the number of sample points in the sequence. Generally, the Fourier transform yields an analysis of a complex waveform into a set of simple additive sinusoidal components. The result, in one of several possible equivalent forms, is frequently referred to as the "spectrum" or "spectral representation" of the waveform. Such an analysis is pictured in Figure 1, for a signal of length T. The complex waveform at the top consists of the additive superposition of the seven simple waveforms below. The numerical representation of the analysis dispenses with the graphical illustrations of the waveforms and presents only the "spectrum" of coefficients of the cosine-and sine-wave components at the different frequencies. Table 1 shows this form of the analysis of the complex waveform at the top of Figure 1. The contribution of the steady component, a_0, is usually called the "DC" component due to the influence of electrical engineers on the terminology. The coefficients, a_1 and b_1, indicate the contributions of the cosine and sine components of period T (in seconds). These components are of frequency 1/T which is called the fundamental frequency or first harmonic. The coefficients, a_2 and b_2, indicate the contributions of the cosine and sine components of period T/2, or at twice the fundamental frequency (second harmonic), while a_3 and b_3 specify the contributions of the components of period T/3, at a frequency

Figure 1.
The complex wave at the top is analyzable into the seven simple sinusoidal components shown below.



Phillip Emerson, Ph.D., Associate Professor, Cleveland State University, College of Arts & Sciences, Cleveland, OH 44115.

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This is the ultimate editing tool for BASIC program lines. There are five commands which allow easier reading of BASIC programs and more efficient execution by the computer.

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SYSTEM SAVERS
ACORN

SYSTEM SAVERS

by Tom Stibolt from Acorn

If you ever use the SYSTEM command, you should buy this two program package. These programs allow you to save any system format tape on tape or disk, plus offer several features for machine language programmers. Many two part, protected system tapes like Sargon II are not system format.

With FLEXL, which is one of the two programs, you can make back-up copies of any system format tape. Most often a cassette that you make will load easier than an original. Plus you can find the filename on any system tape because it is displayed on the screen. And at any time you can stop the reading of the tape by pressing <BREAK>.

For any machine language programmer, FLEXL offers the advantage of producing more efficient tapes than the assembler. Also, it is written to interface directly with monitor programs. And you can merge machine language tapes into one file.

Disk drive owners can use TDISK to save any system format tape onto disk. Adventure, Airaid, Ting-Tong, Editor / Assembler and other programs cannot normally be loaded to disk using TRSDOS. Now, TDISK allows you to save these programs onto disk. After DOS READY you will be able to simply type the filename and be up and running. It even loads non-contiguous tapes. TDISK will greatly increase the benefit of owning a disk drive.

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Complete your system with the routines not found in either Level II or DOS for only $14.95. Order your System Savers, today!

TRS-80 DISK & OTHER MYSTERIES

by H.C. Pennington

We don't usually list books, but this one is so unique that we thought you would want to know about it. There are over 100 pages about how DOS works, how a disk is organized, and how to recover from errors. This is THE technical backup for NEWDOS+ with great illustrations. $22.50.

DISK*MOD

by Roy Soltoff from Misosys

This machine language program modifies your copy of the Radio Shack Editor/Assembler for use with your minidisk and any disk operating system. You can save and load both text source and assembled object files. Unlike the NEWDOS+ version you can read the directory and the allocation of granules while in the EDTASM. You can also kill files. It is a complete disk modification for one or more drives.

Other capabilities are also added which are not found on NEWDOS+. The block move command relocates a section of text to any other area. The global change command permits, for example, changing a label throughout the text. The pagination feature provides hardcopy on 8 1/2 by 11 pages on either single sheets or continous paper. In addition, high memory can be reserved, like in BASIC, for machine language routines like printer drivers. You can also display the amount of memory remaining.

The <CLEAR> key is functional, the symbol table is sorted alphanumerically and output 5-across, the scroll up/down allows 15 lines on the screen, and the 'DEFM' assembly is improved. Lower case input is now permitted and you can branch to any address. Plus, it also corrects the errors in the Radio Shack tape version. $19.95

Also available for $229.95 for the TRS-80 Model II is a similar Editor Assembler from Galactic Software. Write for a complete list of Model II software.

DISASSEMBLER

by Roy Soltoff from Misosys & Acorn

This two-pass Z-80 disassembler produces symbolic labels with output to either the video monitor, printer or tape. Radio Shack's Editor / Assembler can load the tapes. If you own the Editor/Assembler, complete the package with this program. Program on tape for two different memory locations. Cassette version NOW only $14.95

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Transform, cont'd...

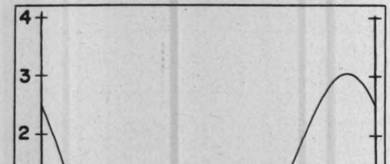
	j			
	0	1	2	3
a_j	1	1	1/2	1/3
b_j		−1	−1/2	−1/3

Table 1
Coefficients of the cosine and sine components of the wave form at the top of Figure 1.

of three times that of the fundamental (the third harmonic). The cosine and sine waves at a given frequency have exactly the same waveform, but one is shifted a quarter of a wavelength in phase relative to the other. The weighted sum of the cosine and sine waves at a given frequency is itself a simple sinusoidal wave of the same form and frequency, but with a phase shift determined by the relative weighting, and with an amplitude equal to the square root of the sum of the squares of the two weights. Although applications of the Fourier transform are not restricted to periodic signals, the terms "frequency," "harmonic," etc., have become standard because many of the early applications were to periodic phenomena in acoustics.

Fourier analysis is still frequently applied to periodic signals such as an acoustical tone, or a carrier wave from a radio transmitter. There are several reasons for doing so, one of the most important being that the nonlinearities of a network can be revealed. The output of a linear network contains only the frequency components that are present in its input. Therefore, the presence of new frequency components in the output indicates a nonlinearity, and the pattern of such new frequency components is sometimes used to characterize the nonlinearity. Aside from analyzing signals to see the contributions of the various frequency components, perhaps before and after the action of an amplifier, it is possible to use the Fourier transform to predict the effects of various kinds of filters on a signal. In fact, it is common to think of filtering in terms of its selective action at various regions along the frequency scale. A lowpass filter attenuates the components at high frequencies, leaving those at lower frequencies relatively unaffected. A simple illustration of this principle is shown in Figure 2, where the complex waveform at the top of Figure 1 has been reconstructed, but with the modification of setting $a_3 = 0$ and $b_3 = 0$. Attenuation of high-frequency components has a "smoothing" effect on the signal.

Figure 2.
A filtered version of the wave shown at the top of Fig. 1. This wave is reconstructed from only the first five of the seven components of Fig. 1.



It is possible to use the Fourier transform to predict the effects of various kinds of filters on a signal.

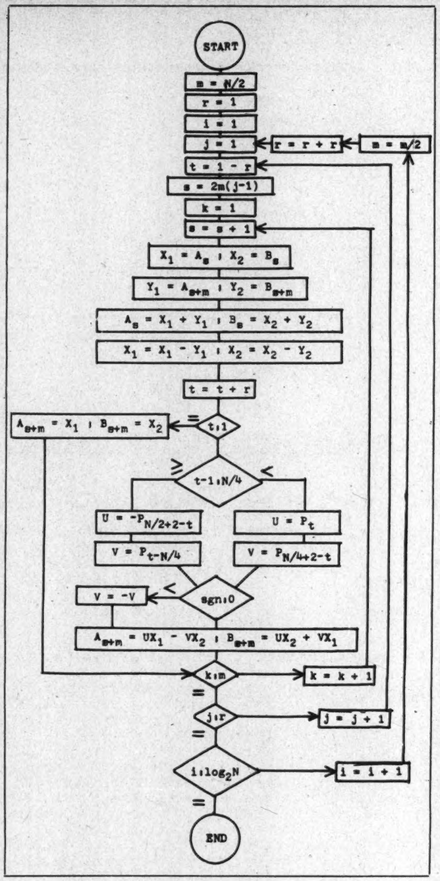


Figure 3.
Fast Fourier transform: the frequency-decimation method with radix 2. This method requires postshuffling which can be done by subsequent execution of the routine of Fig. 4. The variables U and V and the elements of the X, Y, A, B, and P arrays are real variables. All other variables and constants are integers.

For many years, the standard tool in the analysis of speech and other animal sounds, has been an expensive piece of special-purpose hardware that, essentially, performs Fourier transforms on a large number of successive short samples of the sound to be analyzed. Interest in speech analysis has accelerated recently because the market is ready for automatic speech recognition and synthesizing systems (see Robinson, 1979a, 1979b). Also, voice-print systems operate on data in a similar form. Digital numerical techniques for rapid performance of Fourier transforms (i.e., the FFT) have only been in existence for a few years, but in some cases they are replacing the more traditional and highly expensive sound spectrographic hardware. It is now possible for computer hobbyists to dabble with speech analysis and synthesis using only a general purpose digital computer and, perhaps, A-to-D and D-to-A converters. A more general application of the Fourier transform is in the search for periodic components in a signal contaminated by random noise. Ocean tides, sunspots cycles, stock-market fluctuations and various biological phenomena have been analyzed in this way. A noisy signal is transformed, and the spectrum is inspected for any peaks that project above a general amplitude level attributable to the noise. If any peaks are found, an extrapolation equation can be constructed, including only these dominant periodic components, to predict future events with better-than-chance accuracy. The currently popular pseudoscience known as "biorhythm" purports to make predictions of a person's future state of being, on the basis of presumed periodicities in the fluctuations of psychophysiological variables. The implausible part of the theory is that the frequencies of the periodic components are assumed *a priori,* that they all are assumed to begin at a certain phase point at birth, and that they are supposed to remain perfectly locked to the initial phase throughout life. Though there is little doubt that there are important psychobiological rhythms, it is clear that their phases are frequently modified in haphazard ways by environmental events (e.g., pregnancy and the menstrual cycle). Also, it is known that the periods of some of the cycles vary, on the average, from individual to individual. What is needed to make biorhythm serious is the application of the Fourier transform to recent sequences of measurements on the person whose future state is in question. As with tides, sunspots, etc., the significant periodic components would be identified approximately as to frequency, amplitude, and phase, and useful short-range forecasts could be made. Other uses of the FFT, and there are some, are beyond the scope of this article. Papers in the volume edited by Liu (1975) discuss a number of uses and also the logic of the FFT. Blackman & Tukey (1958) have treated many of the questions that arise in the spectral analysis of discrete sequences of measurements of noisy signals.

What is needed to make biorhythm serious is the application of the Fourier transform to recent sequences of measurements on the person whose future state is in question.

The FFT is a certain computational procedure, developed only a few years ago, for performing a Fourier transform on a signal given as a discrete series of numerical measurements, equally spaced. It reduces the number of arithmetical operations from about N^2, for more direct methods, to about $(N\log_2 N)/2$. where N is the number of sample points in the series to be transformed. The time savings are substantial when N is large. The gain in speed is due to some efficiencies that are made possible by performing the calculations in a certain sequence that appears rather complicated, especially if one is trying to modify or translate an existing computer program to a different programming language. The apparent complexity is greatly reduced, here, by the use of a well-known programming crutch, the flow chart. A flow chart concentrates on the logic of the alogrithm, purposely ignoring the idiosyncrasies of the target programming language. The flow chart is general; it can easily be translated into any common programming language. Moreover, the logical structure of a process is much more apparent from a flow chart than from a list of commands. The conventions used in the flow charts presented here are standard. Nonconditional arithmetical operations are enclosed in rectangular boxes. Conditional branches are indicated by diamond shaped boxes, with labels on the outward branches. Lines connect boxes to indicate the flow of control. Generally, the flow is from the top, downward. When the flow is not downward, the direction is indicated by an arrowhead. Labels on outward branches from decision boxes may be omitted when redundant, e.g., if one outward branch is labeled, and there is just one other one, unlabeled, it should be interpreted as the condition complementary to that of the labeled one.

Two algorithms are presented in the flowcharts in Figures 3 and 4, to be used as subroutines that are called by some main program that must minimally handle the input and output to peripheral devices, and define certain parameters. The preparations that must be made before starting to make transformations are as follows. The number of elements, N, in the sequence to be transformed, must be defined as some positive integral power of 2. If the number of points in an actual data sequence to be transformed is not an integral power of 2, a string of zeros should be appended to it to satisfy this requirement. Next, a quarter-wave cosine table must be constructed or read in. In the flow charts, the values are referred to as P_k, $k = 1, 2, \ldots N/4 + 1$. They are defined as $P_k = \cos(2\pi(k - 1)/N)$. The FFT can be performed in the forward (time-to-frequency) or backward (frequency-to-time) direction, with reversal of the algebraic sign of one variable. This sign is taken care of in the flow charts by the variable, sgn, which should be given the value of −1 for a forward transformation, or + 1 for a backward one. There are two N-element arrays operated upon by both subroutines. These are referred to in the flow charts as A_k and B_k, $k = 1, 2, \ldots N$. These arrays should contain the input sequence to be transformed when the FFT is begun, and they will contain the transform when the FFT is finished. The input sequence is not preserved. A pair of elements, (A_k, B_k), implicitly represents a complex number, although the arithmetic operations specified in the flow charts can be programmed as real and integer arithmetic. If your software supports complex arithmetic, you may define a single complex array in place of the A and B arrays. The input data ordinarily will be a time sequence of real numbers. When that is the case, they should be loaded into the A array, and all elements of the B array should be set to zero.

The market is ready for automatic speech recognition and synthesizing systems.

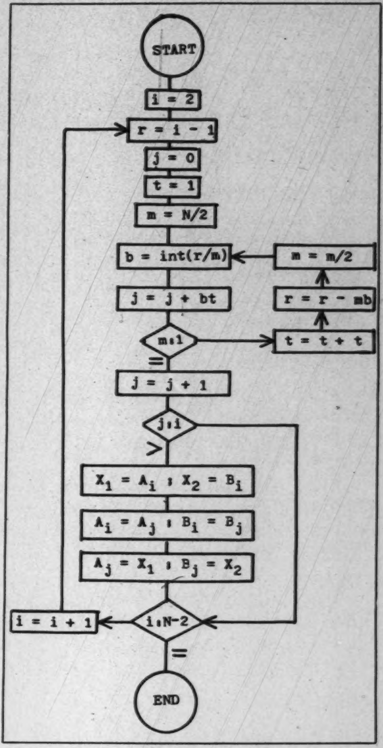


Figure 4.

Shuffle routine for the FFT: binary-address bit reversal. The X, A, and B array elements are real; all other variables and constants are integers.

After the main program has defined N, constructed the cosine table in the P array, defined the value of sgn to be − 1 or + 1, and loaded the data into the A and B arrays, the routines of Figures 3 and 4 should be executed in that order. The first one performs the main computations of the FFT, but leaves the transform in a certain scrambled order. The second routine sorts the frequency components into their natural order. Some of the boxes in the flow charts contain pairs of real operations, separated by semicolons. Each of these pairs corresponds to a complex arithmetical operation, and could be coded as a single complex statement. For software not supporting complex arithmetic, each member

Transform, cont'd...

Table 2
Fast Fourier Transform of a square wave with $N = 8$.

k	A_k	B_k
1	4.000	0.000
2	1.000	−2.414
3	0.000	0.000
4	1.000	−0.414
5	0.000	0.000
6	1.000	0.414
7	0.000	0.000
8	1.000	2.414

of a pair requires a separate real arithmetic statement. The symbol, int(r/m), in Figure 4, means to take the integer part of r/m.

After execution of the routines of Figures 3 and 4, the FFT is complete, but often one wants to identify the results in terms of the notation used earlier to refer to the contributions of the cosine and sine components of the transform, as indicated by the lower-case coefficients, a_0, a_1, b_1, a_2, etc. These are obtainable from the A_k and B_k arrays after the FFT, as

$$a_0 = A_1/N$$
$$a_j = (A_{j+1} + A_{N-j+1})/N$$
$$b_j = (-B_{j+1} + B_{N-j+1})/N,$$

for $j = 1, 2, \ldots N/2$. One can then compute the power at frequency j/T, where T is the duration of the N samples, as $a_j^2 + b_j^2$. The amplitude is the square root of the power.

But before starting to transform actual data, compute power or amplitude spectra, etc., perhaps one should test the program on something simpler. Let $N = 8$. and set the first four elements of the A array to 1, the last four to zero, set all elements of the B array to zero. This is a square wave of period 8. Table 2 shows the result of transforming it to three decimal places. Here are some other tests that can be tried with various values of N. Remember that it is necessary to recompute the elements of the P array when the value of N is changed. Set $A_k = \cos(2\pi(k-1)/N)$ and $B_k = 0$, for $k = 1, 2, \ldots N$, and perform the transformation. The result should be $A_2 = N/2$, $A_N = N/2$, and zeros everywhere else. Next, set $A_k = \sin(2\pi(k-1)/N)$ and $B_k = 0$, for $k = 1, 2, \ldots N$, and transform. You should find $B_2 = -N/2$, $B_N = N/2$, and zeros elsewhere. Set $A_k = 1$ and $B_k = 0$, for $k = 1, 2, \ldots N$. This is DC signal, and the result of transforming it should be $A_1 = N$, and zeros elsewhere. If these tests are successful, within rounding or truncation error, there is another one that is more general, but equally easy to make. The FFT is reversible with the following adjustments. After the transformation from any input sequence to the frequency representation, (1) set sgn = + 1 and (2) divide each element of the A and B arrays by N. Then execute the routines of Figures 3 and 4 again. This should restore the original time sequence. Don't forget to set sgn = − 1 again before starting another transformation in the forward direction. In any case, after a forward transformation, one should find $B_1 = 0$ and, because N is necessarily an even number, $B_{N/2+1} = 0$.

There is no reason why one should not try out the FFT in an interpretive language such as Basic, and perhaps even make some serious use of it for small N. It will execute slowly, however, perhaps taking a second or two even for $N = 8$. For ambitious number crunching with large N, one should plan on converting to a compiler language such as Fortran, or to assembly language. The fastest versions are written in assembly language using integer arithmetic entirely, with periodic rescaling of the numbers to avoid overflow and minimize underflow. Reports of 1.5 seconds for $N = 2048$, and 8 seconds for $N = 8192$, are typical.

The logical structure of a process is much more apparent from a flow chart than from a list of commands.

In addition to the flow charts for the two subroutines, a complete Basic program is included. This program has been tested in SOL Basic/5, and it consists of the two subroutines of

```
LIST
10   REM FROM HERE TO 420 IS A MAIN
20   REM PROGRAM TO READ N, READ DATA, PERFORM
30   REM FFT, PRINT RESULTS, THEN READ ANOTHER
40   REM SET OF DATA, ETC.
50   REM PROGRAM HAS BEEN TESTED WITH SOL
60   REM BASIC/5 ON A PROCESSOR TECHNOLOGY
70   REM SOLOS SYSTEM WITH 16 K OF
80   REM MEMORY.
90   REM
100  DIM A(64),B(64),P(17)
110  PRINT "TYPE N, AN INTEGRAL POWER OF 2, UP TO 64."
120  INPUT N
130  M=1
140  L=0
145  L=L+1
150  M=2*M
160  IF M<N THEN GOTO 145
170  REM L WILL BE LOG2(N)
180  TI=2*3.1415927
185  SI=-1
190  FOR I=1 TO N/4+1
200     P(I)=COS(TI*(I-1)/N)
210  NEXT I
220  PRINT "TYPE IN DATA"
230  FOR I=1 TO N
240     INPUT A(I)
250     B(I)=0
260  NEXT I
270  GOSUB 1200
280  GOSUB 1500
290  PRINT "THE FOURIER TRANSFORM"
300  PRINT "   I              A(I)              B(I)"
310  FOR I=1 TO N
320     PRINT I,A(I),B(I)
325  NEXT I
330  PRINT
332  PRINT
334  PRINT
340  GOTO 220
345  REM
350  REM PROGRAM VARIABLES ARE MOSTLY
360  REM SAME AS THOSE IN FIGS 3 AND 4
370  REM EXCEPTIONS ARE:
380  REM FLOW CHART              PROGRAM
390  REM B(LOWER CASE)              D
400  REM SGN                      SI
410  REM LOG2(N)                   L
420  END
430  REM
440  REM
1200 REM SUBROUTINE FOR MAIN PART
1210 REM OF FFT ALGORITHM
1220 REM (FLOW CHART, FIG. 3)
1230 M=N/2
1240 R=1
1250 FOR I=1 TO L
1260    FOR J=1 TO R
1270       T=1-R
1280       S=2*M*(J-1)
1290       FOR K=1 TO M
1300          S=S+1
1320          X1=A(S)
1325          X2=B(S)
1330          Y1=A(S+M)
1335          Y2=B(S+M)
1340          A(S)=X1+Y1
1345          B(S)=X2+Y2
1350          X1=X1-Y1
1355          X2=X2-Y2
1360          T=T+R
1370          IF T<>1 THEN GOTO 1380
1372          A(S+M)=X1
1374          B(S+M)=X2
1376          GOTO 1420
1380          IF T-1>=N/4 THEN GOTO 1390
1382          U=P(T)
1384          V=P(N/4+2-T)
1386          GOTO 1400
1390          U=-P(N/2+2-T)
1395          V=P(T-N/4)
1400          IF SI>=0 THEN GOTO 1410
1405          V=-V
1410          A(S+M)=U*X1-V*X2
1415          B(S+M)=U*X2+V*X1
1420       NEXT K
1430    NEXT J
1433    M=M/2
1437    R=R+R
1440 NEXT I
1450 RETURN
1460 END
1470 REM
1480 REM
1500 REM SUBROUTINE FOR SHUFFL ROUTINE
1510 REM (FLOW CHART, FIG. 4)
1530 FOR I=2 TO N-2
1540    R=I-1
1550    J=0
1560    T=1
1570    M=N/2
1580    D=INT(R/M)
1590    J=J+D*T
1600    IF M=1 THEN GOTO 1650
1610    T=T+T
1620    R=R-M*D
1630    M=M/2
1640    GOTO 1580
1650    J=J+1
1660    IF J<=I THEN GOTO 1700
1670    X1=A(I)
1675    X2=B(I)
1680    A(I)=A(J)
1685    B(I)=B(J)
1690    A(J)=X1
1695    B(J)=X2
1700 NEXT I
1710 RETURN
1720 END

RUN


TYPE N, AN INTEGRAL POWER OF 2, UP TO 64.

?8
TYPE IN DATA

?1

?1

?1

?1

?1

?1

?1

?1
THE FOURIER TRANSFORM
   I             A(I)            B(I)
  1               8              0
  2               0              0
  3               0              0
  4               0              0
  5               0              0
  6               0              0
  7               0              0
  8               0              0
```

Transform, cont'd...

Figures 3 and 4, with a main program that reads in data to be transformed, defines the parameters, as described above, calls the two subroutines, and puts out the results. In SOL Basic/5, the INPUT command is a request by the program for input directly from the terminal keyboard, rather than from data statements. The PRINT command, in SOL Basic/5, puts information out to the terminal video display. Otherwise, SOL Basic/5 seems to conform to many other versions. The LET command identifier is optional and has been omitted throughout the program. The maximum value of N for the program listed here is 64. This can be changed simply by changing the dimension statement. ☐

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They Are Changing Our Names!

John J. O'Grady

"Just how many people do you have living here, any way, Mr. OGRULY?"

It is no news that people who program computers make many decisions affecting our lives. They have a hand in determining when our bills are due, and mail us letters on every conceivable subject. Now their passion for uniformity is changing the way many of our names are spelled. They are unfamiliar with the admonition attributed to Harry Truman, "I don't care what they say about me, just so long as they spell my name right." If Harry were around today he would find they might talk about him *and* misspell his name.

While I attempt to hang onto this most obvious evidence of my ancestry, I am being deprived of it. It is becoming homogenized into something no longer distinctive, no longer my name.

In my own case, I am happy with my Irish name. The coat-of-arms with background information that I ordered by mail said our clan motto is "Vulneratus Non Victus," Wounded Not Broken. The motto is prophetic, because the name is being wounded and perhaps broken; so are the names of countless others.

While I attempt to hang onto this most obvious evidence of my ancestry, I am being deprived of it. It is being changed without my assent. It is becoming homogenized into something no longer distinctive, no longer my name.

It isn't the O that is dropped, (though sometimes it is moved around); it's the apostrophe. It is disappearing. The apostrophe is being removed by people who set up credit card bills. Department stores feel the same way. So do magazine subscription houses, banks, insurance companies, the government; in fact just about everybody who uses a computer to prepare and print bills or envelopes for large mailings.

The results are interesting, if you don't care how your name is spelled. In my case the most common variation is made by moving the O over as an extra middle initial and I become JOHN J O GRADY. You would think people performing this surgery would feel just a touch of conscience. Not at all. The alterations they perform where they make mailings for the "Whale Report" are major.They cut out the apostrophe, transform two letters and it comes out regularly as OGRULY. Then, to add insult to injury, they furnish their mailing list to others who compound the thing.

Capital letters help blur origins, too, because those of us whose names begin with an O' or a La or De continue the spelling by using another capital letter. When you blend it all together you remove the distinction and it could be a name from any European country. (That well-advertised credit card company might be contributing to the identity crisis.)

If I'm complaining, I wonder how the famous surgeon DeBakey feels about DEBAKEY. The DeCets are probably beginning to accept DECET and the deChadenedes are surely fighting an up-hill battle. So are the LaRosas. The Al-Rashids have become ALRASHID!

You would think people performing this surgery would feel just a touch of conscience. Not at all.

A glance through the phone book indicates that some, weary of the fight, follow the course of least resistance and adopt technology's way. It is not unusual to find Orourke, Oneill, Odonnell, Deluna, Lasasso in telephone listings.

It is a shame for us to submit to name changes when "word processors" haven't thought to include upper and lower case letters on their printing machines or because an apostrophe has been left off the keyboard. All of this in the interest of efficiency and expediency to save one character or a blip on a magnetic tape.

Usually when one requests a correction be made they are met with absolute indifference. "Our computer can't handle that." So, our names bend to accommodate the machinery.

There remains one more weapon for use in my personal battle. It will strike in an area where the blip and character counters can least afford to lose. I can increase the count in my name by three characters by adopting the Gaelic spelling O'Gradaigh. □

John J. O'Grady, 10540 W. 62nd Ave., Arvada, CO 80004.

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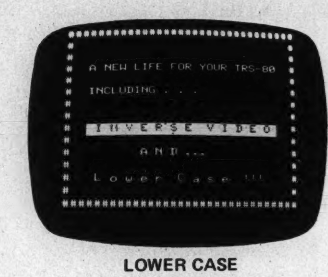
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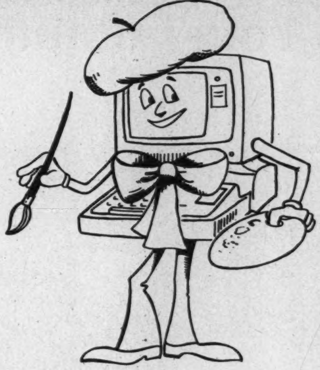

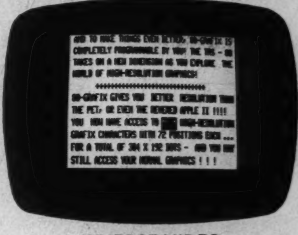
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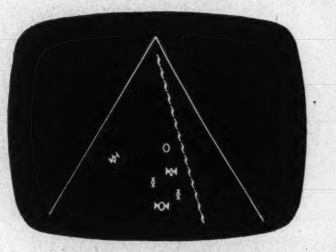

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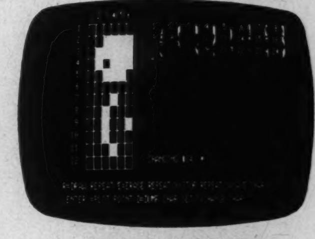

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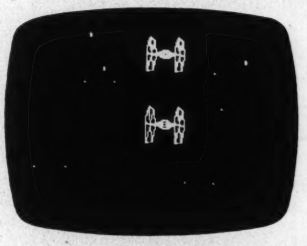

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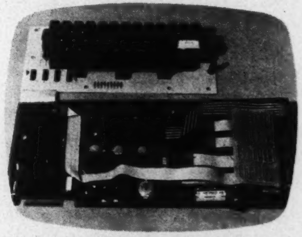

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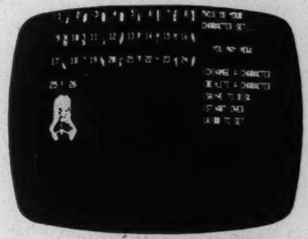
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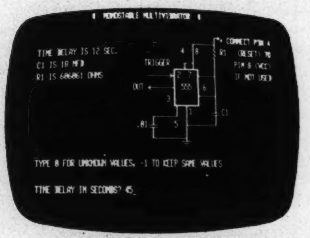
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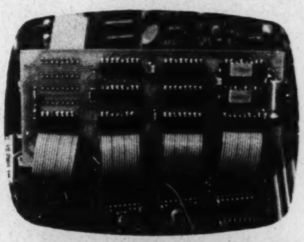

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Put a Dungeon In Your Computer

Glen Charnock

"Dungeons & Dragons" is the most popular of the new breed of "role-playing games" coming on the market. Although it is intended as a pencil and paper game, several versions exist for home computers. There is a fair amount of bookkeeping involved in the game, so if you have a computer you will probably want to make use of it. If you don't already have a computer, perhaps this is just the excuse you've been looking for to buy one. Before we show how a computer can be used, though, let's learn something about the way the game is played.

What Is Dungeons And Dragons?

The basic idea behind Dungeons and Dragons (D&D) is really quite simple. One person is called the Dungeon Master, or DM, and acts as the game moderator. He creates the dungeon by drawing a map of each level of the dungeon. Each map is keyed showing locations of monsters, traps, treasures and other special features. The DM then writes a complete description of the appearance and features of each room or encounter area in the dungeon. The word "dungeon" is used in a generic sense as the actual adventure may take place in any kind of environment — a haunted house, a wilderness, a city, or maybe even a real dungeon.

Each of the other players creates one or more characters which may be fighters, magic users, clerics, or thieves. They may be human, elf, dwarf, halfling, or half-orc. Dice are rolled to determine the characters' Strength, Intelligence, Wisdom, Dexterity, Constitution, Charisma, Wealth and Hit Points (a measure of life force). The players then spend some of their wealth on equipment they wish to take on the adventure.

Finally, all is ready and the expedition enters the dungeon. The game then assumes a dialogue format, with the DM describing what the characters see or what happened to them, and the spokesman for the players telling the DM what the characters are doing. Perhaps an example will make this clearer. This expedition has already been exploring the dungeon for some time:

DM: "You are at an intersection of two corridors, one running north-south and the other east-west."

Player: "We look north."

DM: "The corridor extends as far as you can see (30 feet). There is a door in the West wall 20 feet down the corridor."

Player: "We approach the door and the thief listens at it."

DM: "The door is a stout oaken door and nothing is heard from beyond."

Player: "We try to open the door."

DM: "It's locked."

Player: "The thief tries to pick the lock."

DM: "It was a simple lock and he succeeds."

Player: "We open the door and the two fighters step in, ready for battle."

If you don't already have a computer, perhaps this is just the excuse you've been looking for to buy one.

DM: "You see a room, 30 by 40 feet in size. The door you just entered was in the middle of the 30 foot wall. This room appears to be some sort of burial vault. There are at least a dozen coffins resting on low pedestals spaced throughout the room. Four of the coffins' lids are rising. Skeletons are emerging from them, and a voice seems to come from nowhere booming, 'Who dares disturb the tomb of Kings?' The skeletons have picked up swords and are advancing on the party in a menacing manner."

In the above example, the characters were searching for the crown of the Wolf King which would enable its wearer to control wild wolves that were threatening the characters' village. The goal of an expedition may vary. In this case the characters had to find a specific object. Sometimes the goal is merely to enter the dungeon, find a lot of treasure, and get out alive. Still other games may require that a certain act be performed in some set period of time. The rules are completely flexible and individual creativity is strongly encouraged.

The official rules are published by TSR Hobbies, Inc., PO Box 756, Lake Geneva, WI 53147. You will probably want to start by getting their "Basic Set" which contains a 48-page instruction manual (large pages!) and a prepared dungeon module complete with maps, descriptions, etc. Later, as your interest and funds dictate, you may want to get their other rule books, including the most recent books on "Advanced Dungeons & Dragons." Most game stores carry these and related items, so check your yellow pages under "games." Many game stores also have table space available for players to meet and play D&D or other games, so finding gaming partners shouldn't be a problem.

The above description and example give you the idea of how the game is played. If it sounds good to you so far, by all means get the instructions at your local game store. You will need them, as they contain lists of costs of equipment, tables of monsters and their characteristics, magic spells that your magicians and clerics may use, and details of combat procedures — who gets hit by whom and how much damage is done — and much more.

Glen Charnock, 864 Palomar Way, Oxnard, CA 93030.

Using Your Computer

There are two ways in which a computer can be used. The computer can be programmed to act as a DM so that you play "against" the computer, or you can create one or more programs which will allow the computer to assist the DM or the players (or both) but where a human DM will still be required.

If you decide to let the computer be the DM your job is both simpler and harder. It is harder because the program will be longer and much more complex, but it can also be simpler because there are several such programs already for sale. Jade Computer Products sells "Super Dungeon" for the Apple and "Adventure" is available from national distributors (including *Creative Computing)* for the TRS-80, CP/M, Apple, or PET. If you don't want to buy the game you still have some help in writing one in the form of Scott Adams' detailed article in the August 1979 issue of *Creative Computing.*

A computer DM is an excellent way to introduce someone to this type of role playing game. In fact, my first experience was with a form of Adventure on a DEC 2020 system at the National Computer Conference. It can also be a fun way to pass some time even if you normally play with a live DM. Unfortunately, the computer DM is always limited no matter how complex the program. (This is more a practical than a theoretical limitation — an unlimited computer DM would require too much memory and would be too slow on a hobby computer). Since one of the most important parts of D&D is that it encourages individual creativity, I feel that a computer DM will always lack an essential element of the game. I enjoy playing against a computer, but if given a choice, I'll take a live DM every time. Let's take an example. You have written code in your computer DM to allow for players encountering a door. They may listen at it and test to see if it is locked. If unlocked they may open it, and if locked they may try to pick the lock or break it down by force. Your new player has gotten locked in the room. He doesn't want to make much noise lest he attract the enemy guards, and he was unsuccessful at picking the lock. Did you allow for him removing the hinges and sliding the door out of its frame? You didn't? Gee, that's too bad, you just stifled his creativity. This situation actually arose in a live game. (The hero got away safely — that time.) Murphy's law applies strongly to computer DM's. No matter how many alternatives you have allowed for, your players will always find one which you didn't and will usually find it the first time they enter your dungeon.

If you do decide to write your own computer DM, at least be sure it is nice and flexible like Scott Adams' so you can fix these little problems as you find them.

A Computer DM

Writing a computer DM program is similar in many ways to writing an interpreter. You, the player, give some command to the program, it is acted upon, and the result is returned to you. The key to success is to have a well designed data base consisting of information about the dungeon, its geography, and contents. See the Scott Adams article mentioned earlier for a good example.

The data base must contain all the information needed for any command that the player may give. Therefore, before you can set up a data base you must know what commands are to be allowed. From that you can determine what information must be kept in your data base. Let's look at some common commands and see what sort of things a computer DM may be able to handle.

Super Dungeon (mentioned earlier) begins with only the commands WALK, RUN, OPEN DOOR, CLOSE DOOR and HELP. Most of these are obvious. HELP prints the list of usable commands which may be augmented as the player gains experience or acquires new devices.

Some other commands you may want to allow in your DM are: MOVE, CLIMB, GO UP, GO DOWN, LOOK, EXAMINE, SEARCH, LISTEN, OPEN (jar, bottle, chest, door, or whatever), CLOSE (same list), PICK A LOCK, CAST A SPELL, FIGHT, HIT, THROW, EAT, DRINK, TASTE, SIP, TAKE, PICK UP, GRAB, STEAL, SAY, SPEAK, TOUCH, FEEL, POKE, TEST, SHOW, DISPLAY, MAP, READ, PUT ON (ring, cloak, etc.).

Again, most of these are obvious. LOOK gives a description of the room or hall you are in, while EXAMINE gives a detailed description of an object such as a book, table, etc. SEARCH will find hidden items in the area searched. LISTENing at closed doors is frequently a good idea before you barge in! (Just watch out for one problem — in one game a player listened at a door soon after entering the dungeon and heard heavy breathing sounds and a heartbeat, "Lub dub, lub dub, . . . " He didn't want to find out what that was! For the next half hour, every door he listened to hid a similar creature. Always the same heavy breathing and heartbeat. Finally, he couldn't stand the suspense and opened one of the doors. There was nothing there! Just an empty room. Eventually he realized that when listening he hadn't taken off his helmet and each time he had heard his own breathing and heartbeat!)

TASTE and SIP allow a player to sample an edible item without actually ingesting a full dose. This way you may find out if food is poisoned, or you may get a hint of the effects of some magic potion you have found without having the full effect hit you. POKE, TEST, or FEEL may be defined to allow cautious players to test something without actually touching it themselves. Poking something with the far end of a 10 foot pole before going closer has saved many lives. SHOW, DISPLAY and MAP may be used to inquire into the computer's data base. You may, for example, want to show what items are in a character's possession, or review the dungeon map if your program generates one for you. Many magic items are made in the form of jewelry or garments. PUT ON allows you to acquire their magic abilities (assuming you have such an item to put on). Likewise TAKE OFF allows the removal of the item.

There are at least a dozen coffins resting on low pedestals spaced throughout the room. Four of the coffins' lids are rising.

If all of this sounds complicated, there is a good reason. It is. A computer DM can be as complicated as you care to make it. When built on a good data base and using modular coding techniques, the result can be a powerful program that is still easy to understand and modify.

When writing your computer DM, start with a small set of commands and add more as you find you need them. In this way you can debug as you go and your program will grow along with your experience.

The Computer As A Support Tool

Even if you don't want to write a computer DM program, there are a number of ways in which your computer can help you play or DM. The first program you will probably want as a player is a good character generator. See the accompanying listing. This program allows you to choose whether you want to create a fighter, magic user, cleric, or thief and whether he should be human, elven, dwarven, halfling, or half-orc. If necessary, it should be a straightforward job to add new classes or races by following the pattern of the existing code. Once you have chosen a class and race, the program generates random numbers for the basic attributes (Strength, Intelligence, Wisdom, Dexterity, Con-

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Dungeon, cont'd...

stitution and Charisma). Next, these scores are modified according to the character's race. Dwarves, for example, are sturdier but less likeable than humans so their constitution is increased one but their charisma score is lowered one point. There are also minima and maxima for each attribute which varies according to the race and the scores are adjusted to comply with these restrictions. Likewise, there are limits based on the character's class so the scores are adjusted again to comply with these limits. The character's wealth and hit points are based on his class so these random numbers are generated next. (Hit Points, sometimes referred to as Hits To Kill, are a measure of how much damage a character can sustain before dying.)

At this point, the basic data about the character is printed. The character's attributes determine his abilities. For example, a player with a high charisma of 18 could hire up to 15 henchmen while a player with only a charisma of 3 could hire but 1 henchman. These details are printed next. Due to lack of memory on the computer I was using, I have included only the strength and intelligence modules but it should be obvious on examining them how to add modules for the other abilities. Simply insert the GOSUBs after line 1330 and the modules themselves starting at 4600. In a similar manner, data related to the character's race and class are printed next. Finally, the program loops to allow you to generate more characters.

Once you have your character generator program running, you may want to write a combat program. The computer, having been fed data about the combatants (names, hit points, armor, weapons, etc.) can conduct the battle and print a detailed description of who was hit by whom, where, how much damage, etc. A good human DM can do this also, but usually the attempt bogs down in looking up tables to see whether a hit was in the hand, foot, body, etc. and how much damage the limb in question was able to survive. The computer is much faster and can maintain all these tables in its memory and so produce lively combat.

You may want the computer to help with your bookkeeping tasks. It can keep track of the time spent and advise when rest or food is needed. It can tell when a torch is burnt out or how much oil you have left, who is carrying which treasure, etc. Many times this bookwork is left undone because it slows down the game. Since the computer can do it easily and quickly, detailed accounting becomes feasible and adds a new dimension of reality to the game.

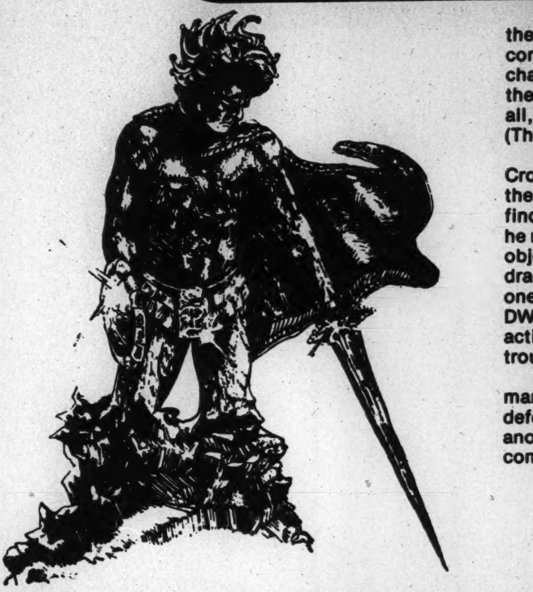
A more ambitious project might be to allow the computer to map the dungeon as the players explore it. Players would enter the dimensions given by the DM relating to what they see, and the computer would use its graphic display to provide the map. One thing that will cause a problem with players or computers creating maps is a teleportation device. Your character steps through an ordinary looking door and vanishes. He has been teleported to some other area of the dungeon. He may or may not realize that he has been moved. Eventually the map will begin showing inconsistencies and the player may suspect something funny has happened but even so, may not know just where or what it was. Your program must somehow allow for these situations to be resolved and any incorrect segments of the map to be corrected. You may even want to implement a "save" command that you may give to instruct the program to save the current state of the map on disk so that it can be retrieved later to aid in correcting such situations. More than one map should be "saveable" so that there can be several generations of backup maps. If you do get lost, the DM should not help you find yourself again. You must retrace your steps as best as you are able in order to find out where you went wrong. This is just what you would have to do if you were there in person.

No matter how many alternatives you have allowed for, your players will always find one which you didn't and will usually find it the first time they enter your dungeon.

No matter what sort of programs you want to use to assist you, always consider whether you might someday want to include that routine in a computer DM program, then plan ahead to minimize conversion efforts if you do decide to use it later. If you aren't sure how to do this, look for articles or books on "Modular" design and on "structured programming." These techniques will help in any programming you do, whether it's today's game or tomorrow's payroll. Good luck and happy dungeoning. □

It would be a swell world if everybody was as pleasant as the fellow who's trying to skin you.

A New Type of Game



Welcome to an astonishing new experience! **ADVENTURE** is one of the most challenging and innovative games available for your personal computer. This is not the average computer game in which you shoot at, chase, or get chased by something, master the game within an hour, and then lose interest. In fact, it may take you more than an hour to score at all, and will probably take days or weeks of playing to get a good score. (There is a provision for saving a game in progress).

The original computer version of Adventure was written by Willie Crowther and Don Woods in Fortran on a PDP-10 at MIT. In this version the player starts near a small wellhouse. Upon entering the house, he finds food, water, a set of keys and a lamp. Armed with only these items, he must set out to explore the countryside in search of treasure and other objects of play. He must also confront dwarfs, snakes, trolls, bears, dragons, birds, and other creatures during his quest. The game accepts one-or two-word commands such as GET LAMP* SOUTH* or KILL DWARF. Of course, if you don't have the proper tool to carry out an action, or if you do something foolish, you may find yourself in big trouble.

In playing the game you wander thru various 'rooms' (locations), manipulating the objects there to try to find 'treasures'. You may have to defeat an exotic wild animal to get one treasure, or figure out how to get another treasure out of a quicksand bog. You communicate thru two-word commands such as 'go west', 'climb tree', 'throw axe', 'look around'.

Adventure

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```
LIST
10 REM *** DOCUMENTATION SECTION ***
20 REM
30 REM THIS PROGRAM GENERATES CHARACTERS FOR TSR'S
   DUNGEONS AND DRAGONS
40 REM WRITTEN BY GLEN CHARNOCK 9-2-79 IN NORTH STAR BASIC
50 REM
60 REM A(X) CONTAINS - 1 STRENGTH, 2 INTELLIGENCE,3 WISDOM
70 REM                 4 DEXTERITY,5 CONSTITUTION,6 CHARISMA
80 REM H6 = HIT POINTS OR "HITS TO KILL"
90 REM H4 = HIT DICE TYPE (4, 6, 8, OR 10 SIDED)
100 REM S2 = SUPER STRENGTH IF AND ONLY IF A(1)=18 AND C=1
110 REM L = CHARACTERS LEVEL (ALWAYS 1 IN THIS PROGRAM)
120 REM R = CHARACTERS RACE - 1 HUMAN, 2 ELF, 3 DWARF,
   4 HALFLING,
130 REM                          5 HALF-ORC
140 REM C = CHARACTERS CLASS - 1 FIGHTER, 2 MAGIC USER,
   3 CLERIC, 4 THIEF
150 REM N = NUMBER OF DICE TO ROLL
160 REM D = TYPE OF DICE (NUMBER OF SPOTS PER DIE)
170 REM T = TOTAL FOR ROLLING N D-SIDED DICE
180 REM G6 = GOLD PIECES (CHARACTER'S WEALTH)
210 REM I,J,K - LOOP INDICIES
220 REM A$ - NAME OF CHARACTER'S RACE
230 REM B$ - NAME OF CHARACTER'S CLASS
299 REM
300 REM *** INITIALIZATION SECTION ***
310 REM
320 DIM A(6)
330 T = RND(-1) \ REM INITIALIZE RANDOM NUMBER GENERATOR
340 L = 1
350 DIM B$(28)
360 DIM C$(16)
370 DIM D$(22)
380 DIM E$(19)
390 DIM F$(16)
395 DIM G$(24)
399 REM
400 REM *** INSTRUCTIONS SECTION ***
410 REM
420 PRINT\PRINT\PRINT
430 PRINT "THIS PROGRAM GENERATES CHARACTERS FOR TSR'S
   GAME OF"
440 PRINT "DUNGEONS AND DRAGONS.  YOU MAY GENERATE CHARACTERS OF ANY"
450 PRINT "VALID COMBINATION OF CLASS AND RACE FROM THE FOLLOWING TABLE"
460 PRINT "CLASS 1  FIGHTER       RACE 1 HUMAN"
470 PRINT "CLASS 2  MAGIC USER    RACE 2 ELF"
480 PRINT "CLASS 3  CLERIC        RACE 3 DWARF"
490 PRINT "CLASS 4  THIEF         RACE 4 HALFLING"
500 PRINT "                       RACE 5 HALF-ORC"
510 PRINT
520 PRINT "ENTERING A 0,0 TERMINATES THE PROGRAM"
530 PRINT "ENTERING -1,-1 CAUSES THE INSTRUCTIONS TO REPEAT"
540 PRINT
550 PRINT "WHEN REQUESTED, ENTER THE CLASS NUMBER, A COMMA, AND THE"
560 PRINT "RACE NUMBER THAT YOU DESIRE"
570 PRINT "GOOD LUCK ON YOUR ROLLS"
580 PRINT\PRINT\PRINT
599 REM
600 REM *** INPUT SECTION ***
610 REM
620 INPUT "ENTER CLASS, RACE NUMBERS ",C,R
630 IF C=0 AND R=0 THEN STOP
640 IF C=-1 AND R=-1 THEN GOTO 420
650 IF C(1 OR C)4 OR R(1 OR R)5 THEN GOTO 420
660 IF C=2 AND (R=3 OR R=4 OR R=5) THEN GOTO 9820
670 IF C=3 AND (R=2 OR R=3 OR R=4) THEN GOTO 9820
```

```
680 REM  ONLY CERTAIN RACES MAY BE CLERICS OR MAGIC USERS
699 REM
700 REM *** GENERATE BASIC ATTRIBUTES ***
710 REM
720 REM METHOD 3 - ROLL 3D6 6 TIMES FOR EACH CATEGORY AND USE THE
730 REM            HIGHEST OF EACH GROUP OF 6
740 REM
750 N=3\D=6
760 FOR I=1 TO 6
770 A(I) = 0
780 FOR J = 1 TO 6
790 GOSUB 9920
800 IF T)A(I) THEN A(I)=T
810 NEXT J
820 NEXT I
899 REM
900 REM *** EDIT AND ADJUST SCORES BY RACE ***
910 REM
920 ON R GOTO 2020,2120,2320,2520,2720
930 REM RETURN HERE FROM ABOVE GOTO'S
999 REM
1000 REM *** EDIT AND ADJUST SCORES BY CLASS, COMPUTE HP AND WEALTH ***
1010 REM
1020 ON C GOTO 2920,3220,3420,3620
1030 REM RETURN HERE FROM ABOVE GOTO'S
1099 REM
1100 REM *** PRINT CHARACTER ***
1110 REM
1120 PRINT\PRINT
1130 PRINT A$," ",B$,"  NAME =                         SEX = "
1140 PRINT\PRINT "ALIGNMENT = "\PRINT
1150 PRINT "STRENGTH",TAB(15),A(1),
1160 IF C=1 AND A(1)=18 THEN PRINT "/",S2,TAB(26),ELSE
1170 PRINT "INTELLIGENCE",TAB(40),A(2)    PRINT TAB(26),
1180 PRINT "WISDOM",TAB(15),A(3),TAB(26),"DEXTERITY",TAB(40),A(4)
1190 PRINT "CONSTITUTION",TAB(15),A(5),TAB(26),"CHARISMA",TAB(40),A(6)
1200 PRINT
1210 PRINT "HITS TO KILL",TAB(15),H6,"  (",L,"D",H4,")"
1220 PRINT
1230 PRINT "WEALTH = ", G6, " GP"
1240 PRINT
1299 REM
1300 REM *** PRINT ABILITIES BASED ON ATTRIBUTES A(1) THRU A(6)***
1310 REM
1320 GOSUB 3820 \ REM STRENGTH
1330 GOSUB 4320 \ REM INTELLIGENCE
1399 REM
1400 REM *** PRINT ABILITIES BASED ON CHARACTER'S RACE ***
1410 REM
1415 PRINT
1420 IF R=1 THEN GOSUB 8320\ REM PRINT HUMAN DATA
1430 IF R=2 THEN GOSUB 8420 \REM PRINT ELVEN DATA
1440 IF R=3 THEN GOSUB 8620 \REM PRINT DWARF DATA
1450 IF R=4 THEN GOSUB 10020 \REM PRINT HALFLING DATA
1460 IF R=5 THEN GOSUB 10220 \REM PRINT HALF-ORC DATA
1499 REM
1500 REM *** PRINT ABILITIES BASED ON CHARACTER'S CLASS ***
1510 REM
1520 PRINT
1530 IF C=1 THEN GOSUB 8920 \REM PRINT FIGHTER DATA
1540 IF C=2 THEN GOSUB 9020 \REM PRINT MAGIC USER DATA
1550 IF C=3 THEN GOSUB 9120 \REM PRINT CLERIC DATA
1560 IF C=4 THEN GOSUB 9220 \REM PRINT THIEF DATA
1590 PRINT
1599 REM
1700 REM *** LOOP FOR NEXT CHARACTER ***
```

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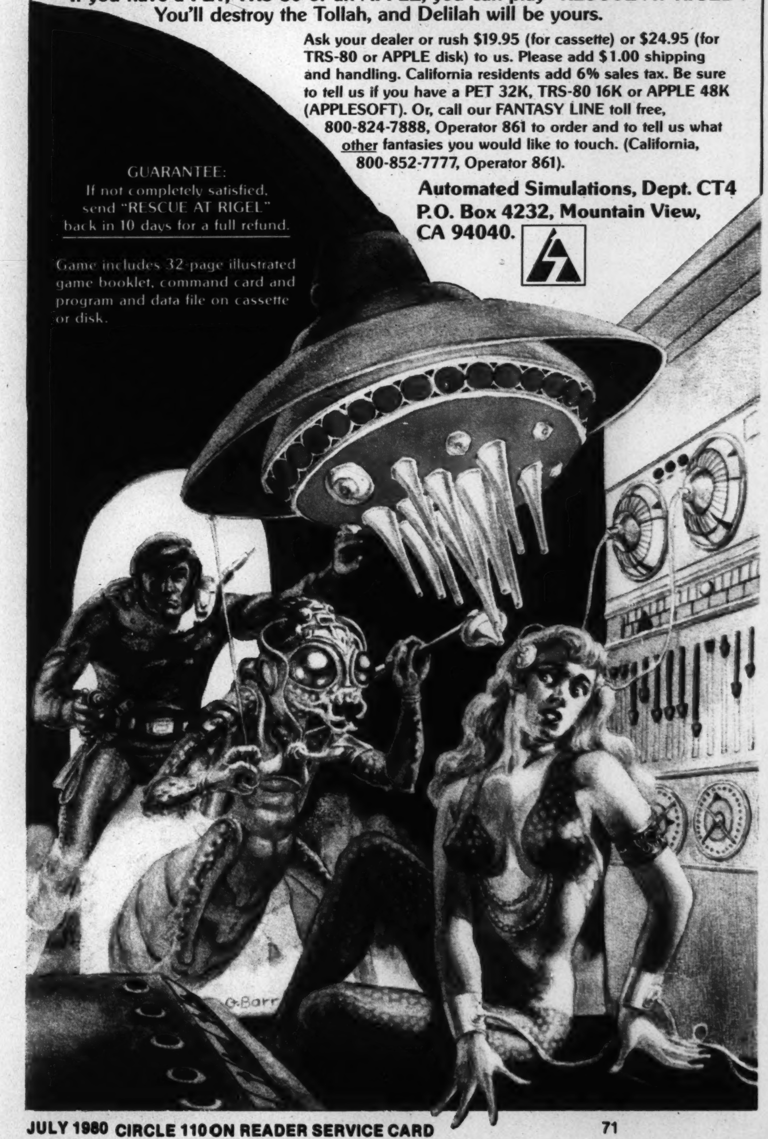

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CIRCLE 110 ON READER SERVICE CARD

```
1710 REM
1720 GOTO 620
2000 REM *** EDIT HUMAN SCORES ***
2010 REM
2020 A$ = "HUMAN"
2030 GOTO 930
2040 REM HUMANS HAVE NO LIMITS AND NO ADJUSTMENTS
2099 REM
2100 REM *** EDIT AND ADJUST ELVEN SCORES ***
2110 REM
2120 A$ = "ELVEN"
2130 A(4) = A(4)+1
2140 A(5) = A(5)-1
2150 IF A(1)(3 THEN A(1)=3\ IF A(1))18 THEN A(1)=18
2160 IF A(2)(8 THEN A(2)=8\ IF A(2))18 THEN A(2)=18
2170 IF A(3)(3 THEN A(3)=3\ IF A(3))18 THEN A(3)=18
2180 IF A(4)(7 THEN A(4)=7\ IF A(4))19 THEN A(4)=19
2190 IF A(5)(6 THEN A(5)=6\ IF A(5))18 THEN A(5)=18
2200 IF A(6)(8 THEN A(6)=8\ IF A(6))18 THEN A(6)=18
2210 GOTO 930
2299 REM
2300 REM *** EDIT AND ADJUST DWARVEN CHARACTERISTICS ***
2310 REM
2320 A$ = "DWARVEN"
2330 A(5) = A(5)+1 \REM CONSTITUTION+1
2340 A(6) = A(6)-1 \ REM CHARISMA -1
2350 IF A(1)(8 THEN A(1)=8 \ IF A(1))18 THEN A(1)=18
2360 IF A(2)(3 THEN A(2)=3 \ IF A(2))18 THEN A(2)=18
2370 IF A(3)(3 THEN A(3)=3 \ IF A(3))18 THEN A(3)=18
2380 IF A(4)(3 THEN A(4)=3 \ IF A(4))17 THEN A(4)=17
2390 IF A(5)(12 THEN A(5)=12 \ IF A(5))19 THEN A(5)=19
2400 IF A(6)(3 THEN A(6)=3 \ IF A(6))16 THEN A(6)=16
2410 GOTO 930
2499 REM
2500 REM *** EDIT AND ADJUST HALFLINGCHARACTERISTICS ***
2510 REM
2520 A$ = "HALFLING"
2530 A(1) = A(1)-1
2540 A(4) = A(4)+1
2550 IF A(1)(6 THEN A(1)=6 \ IF A(1))17 THEN A(1)=17
2560 IF A(2)(6 THEN A(2)=6 \ IF A(2))18 THEN A(2)=18
2570 IF A(3)(3 THEN A(3)=3 \ IF A(3))17 THEN A(3)=17
2580 IF A(4)(8 THEN A(4)=8 \ IF A(4))18 THEN A(4)=18
2590 IF A(5)(10 THEN A(5)=10 \ IF A(5))19 THEN A(5)=19
2600 IF A(6)(3 THEN A(6)=3 \ IF A(6))18 THEN A(6)=18
2610 GOTO 930
2699 REM
2700 REM *** EDIT AND ADJUST HALF-ORC CHARACTERISTICS ***
2710 REM
2720 A$ = "HALF-ORC"
2730 A(1) = A(1)+1 \ REM STRENGTH+1
2740 A(5) = A(5)+1 \ REM CONSTITUTION+1
2750 A(6) = A(6)-2 \ REM CHARISMA-2
2760 IF A(1)(6 THEN A(1)=6 \ IF A(1))18 THEN A(1)=18
2770 IF A(2)(3 THEN A(2)=3 \ IF A(2))17 THEN A(2)=17
2780 IF A(3)(3 THEN A(3)=3 \ IF A(3))14 THEN A(3)=14
2790 IF A(4)(3 THEN A(4)=3 \ IF A(4))14 THEN A(4)=14
2800 IF A(5)(13 THEN A(5)=13 \ IF A(5))19 THEN A(5)=19
2810 IF A(6)(3 THEN A(6)=3 \ IF A(6))12 THEN A(6)=12
2820 GOTO 930
2899 REM
2900 REM *** EDIT AND ADJUST FIGHTERS' CHARACTERISTICS***
2910 REM
2920 B$ = "VETERAN (FIGHTER)"
2930 IF A(1)(9 THEN A(1)=9
2940 IF A(3)(6 THEN A(3)=6
2950 IF A(4)(6 THEN A(4)=6
2960 IF A(5)(7 THEN A(5)=7
2970 IF A(6)(6 THEN A(6)=6
2980 IF A(1))18 THEN A(1)=18
2990 N=1\D=100
3000 GOSUB 9900 \ REM ROLL DICE
3010 S2 = T
3030 IF A(1)(18 THEN S2=0
3040 N=1\D=10\H4=10
3050 GOSUB 9900\ REM ROLL DICE
3060 H6=T
3070 N=5\D=4
3080 GOSUB 9900 \ REM ROLL DICE
3090 G6 = T*10
3100 GOSUB 8800 \REM  APPLY CONSTITUTION ADJUSTMENT TO HIT POINTS
3110 GOTO 1030
3199 REM
3200 REM *** EDIT AND ADJUST MAGICIANS CHARACTERISTICS ***
3210 REM
3220 B$ = "PRESTIDIGITATOR (MAGICIAN)"
3230 N=1\D=4\H4=4
3240 GOSUB 9900 \ REM ROLL DICE
3250 H6 = T
3260 N=2\D=4
3270 GOSUB 9900
3280 G6 = T*10
3290 S2 = 0
3300 GOSUB 8800 \ REM ADJUST HIT POINTS BASED ON CONSTITUTION
3310 IF A(1))18 THEN A(1)=18
3320 IF A(2)(9  THEN A(2)=9
3330 IF A(3)(6  THEN  A(3)=6
3340 IF A(4)(6  THEN A(4)=6
3350 IF A(5)(6  THEN A(5)=6
3360 IF A(6)(6  THEN A(6)=6
3370 GOTO 1030
3399 REM
3400 REM *** EDIT AND ADJUST CLERICS CHARACTERISTICS ***
3410 REM
3420 B$ = "ACOLYTE (CLERIC)"
3430 N=1\D=8\H4=8
3440 GOSUB 9900 \ REM ROLL DICE
3450 H6 = T
3460 GOSUB 8800 \ REM ADJUST H6 BASED ON CONSTITUTION
3470 N=3\D=6
3480 GOSUB 9900
3490 G6 = T*10
3500 S2 = 0
3510 IF A(1)(6 THEN A(1)=6 \ IF A(1))18 THEN A(1)=18
3520 IF A(2)(6 THEN A(2)=6
3530 IF A(3)(9 THEN A(3)=9
3540 IF A(5)(6 THEN A(5)=6
3550 IF A(6)(6 THEN A(6)=6
3560 GOTO 1030
3599 REM
3600 REM *** EDIT AND ADJUST THIEVES CHARACTERISTICS ***
3610 REM
3620 B$ = "ROGUE (THIEF)"
3630 N=1\D=6\H4=6
3640 GOSUB 9900 \ REM ROLL DICE
3650 H6 = T
3660 GOSUB 8800 \ REM ADJUST HIT POINTS BASED ON CONSTITUTION
3670 N=2\D=6
3680 GOSUB 9900
3690 G6 = T*10
3700 S2 = 0
3710 IF A(1)(6 THEN A(1)=6 \ IF A(1))18 THEN A(1)=18
3720 IF A(2)(6 THEN A(2)=6
```

TAPE or DISK
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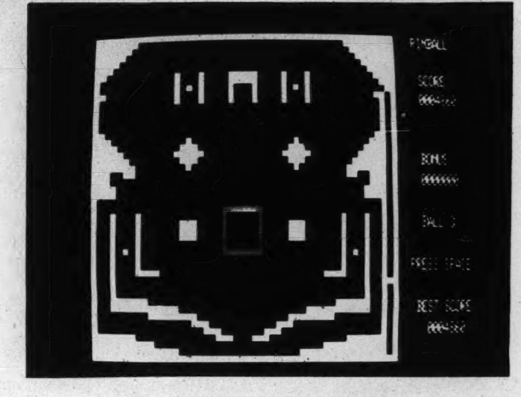
PINBALL

by John Allen



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Acorn produces several games for the TRS-80* These include: *Codebreaker, Star Warp & Lunar Lander, Word Challenge, Bandito, Block'em* and *Ting-Tong* priced at $9.95. *Pigskin, Invaders From Space,* and *Quad* are available for $14.95. Ask for these and other quality Acorn programs at your local computer store.

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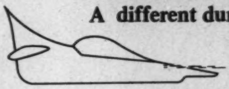

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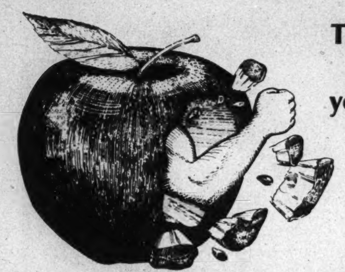
CIRCLE 112 ON READER SERVICE CARD

```
3730 IF A(4)<9 THEN A(4)=9
3740 IF A(5)<6 THEN A(5)=6
3750 IF A(6)<6 THEN A(6)=6
3760 GOTO 1030
3799 REM
3800 REM *** PRINT STRENGTH ABILITIES ***
3810 REM
3820 C$="HIT PROBABILITY "
3830 D$="  DAMAGE ADJUSTMENT "
3840 E$="  WEIGHT ALLOWANCE "
3850 F$="  OPEN DOORS ON "
3860 G$="  BEND BARS/LIFT GRATES "
3870 A1 = A(1)
3880 IF A1<4 THEN PRINT C$,"-3",D$,"-1",E$,"-250"
3890 IF A1<4 THEN PRINT F$,"1/6",G$,"0%"
3900 IF A1=4 OR A1=5 THEN PRINT C$,"-2",D$,"-1",E$,"-250"
3910 IF A1=4 OR A1=5 THEN PRINT F$,"1/6",G$,"0%"
3920 IF A1=6 OR A1=7 THEN PRINT C$,"-1",D$,"NONE",E$,"-150"
3930 IF A1=6 OR A1=7 THEN PRINT F$,"1/6",G$,"0%"
3940 IF A1=8 OR A1=9 THEN PRINT C$,"NORMAL",D$,"NONE",E$,"NORMAL"
3950 IF A1=8 OR A1=9 THEN PRINT F$,"1-2/6",G$,"1%"
3960 IF A1=10 OR A1=11 THEN PRINT C$,"NORMAL",D$,"NONE",E$,"NORMAL"
3970 IF A1=10 OR A1=11 THEN PRINT F$,"1-2/6",G$,"2%"
3980 IF A1=12 OR A1=13 THEN PRINT C$,"NORMAL",D$,"NONE",E$,"+100"
3990 IF A1=12 OR A1=13 THEN PRINT F$,"1-2/6",G$,"4%"
4000 IF A1=14 OR A1=15 THEN PRINT C$,"NORMAL",D$,"NONE",E$,"+200"
4010 IF A1=14 OR A1=15 THEN PRINT F$,"1-2/6",G$,"7%"
4020 IF A1=16 THEN PRINT C$,"NORMAL",D$,"+1",E$,"+350"
4030 IF A1=16 THEN PRINT F$,"1-3/6",G$,"10%"
4040 IF A1=17 THEN PRINT C$,"+1",D$,"+1",E$,"+500"
4050 IF A1=17 THEN PRINT F$,"1-3/6",G$,"13%"
4060 IF A1<18 THEN RETURN
4070 REM FOR STRENGTH 18 WE MUST CHECK SUPER STRENGTH (S2)
4080 IF S2=0 THEN PRINT C$,"+1",D$,"+2",E$,"+750"
4090 IF S2=0 THEN PRINT F$,"1-3/6",G$,"16%"
4100 IF S2>0 AND S2<51 THEN PRINT C$,"+1",D$,"+3",E$,"+1000"
4110 IF S2>0 AND S2<51 THEN PRINT F$,"1-3/6",G$,"20%"
4120 IF S2>50 AND S2<76 THEN PRINT C$,"+2",D$,"+3",E$,"+1250"
4130 IF S2>50 AND S2<76 THEN PRINT F$,"1-4/6",G$,"25%"
4140 IF S2>75 AND S2<91 THEN PRINT C$,"+2",D$,"+4",E$,"+1500"
4150 IF S2>75 AND S2<91 THEN PRINT F$,"1-4/6",G$,"30%"
4160 IF S2>90 AND S2<100 THEN PRINT C$,"+2",D$,"+5",E$,"+2000"
4170 IF S2>90 AND S2<100 THEN PRINT F$,"1-4/6 (1/6 LOCKED OR MAGIC)",G$,"35%"
4180 IF S2>99 THEN PRINT C$,"+3",D$,"+6",E$,"+3000"
4190 IF S2>99 THEN PRINT F$,"1-5/6 (1-2/6 LOCKED OR MAGIC)",G$,"40%"
4200 RETURN
4299 REM
4300 RwM *** PRINT INTELLIGENCE ABILITIES ***
4310 REM
4320 I2=0
4330 IF A(2)>7 THEN I2=1
4340 IF A(2)>9 THEN I2=2
4350 IF A(2)>11 THEN I2=3
4360 IF A(2)>13 THEN I2=4
4370 IF A(2)=16 THEN I2=5
4380 IF A(2)=17 THEN I2=6
4390 IF A(2)=18 THEN I2=7
4400 PRINT
4410 PRINT " THE CHARACTER MAY LEARN ",I2," ADDITIONAL LANGUAGES"
4420 IF C<>2 THEN RETURN
4430 REM  THE CHARACTER IS A MAGIC USER (C=2)
4440 C$="CHARACTER HAS A "
4450 D$="% CHANCE TO KNOW FROM "
4460 E$=" TO "
4470 F$=" SPELLS"
4480 IF A(2)=9 THEN PRINT C$,35,D$,4,E$,6,F$
4490 IF A(2)>9 AND A(2)<13 THEN PRINT C$,45,D$,5,E$,7,F$
4500 IF A(2)=13 OR A(2)=14 THEN PRINT C$,55,D$,6,E$,9,F$
4510 IF A(2)=15 OR A(2)=16 THEN PRINT C$,65,D$,7,E$,11,F$
4520 IF A(2)=17 THEN PRINT C$,75,D$,8,E$,14,F$
4530 IF A(2)=18 THEN PRINT C$,85,D$,9,E$,18,F$
4540 IF A(2)>18 THEN PRINT C$,95,D$,10,E$,"THRU ALL SPELLS"
4550 RETURN
4599 REM
8300 REM *** PRINT HUMAN DATA ***
8310 REM
8320 PRINT " HUMANS ARE CONSIDERED 'NORMAL' IN THIS WORLD AND HAVE"
8330 PRINT " NO SPECIAL ABILITIES"
8340 RETURN
8399 REM
8400 REM *** PRINT ELVEN DATA ***
8410 REM
8420 PRINT " ELVES HAVE A 90% RESISTANCE TO SLEEP AND CHARM SPELLS"
8430 PRINT " ELVES HAVE +1 TO HIT WHEN USING SWORDS OR ANY BOWS EXCEPT"
8440 PRINT " CROSSBOWS.  THEY MAY SPEAK ELVISH, GNOME, HALFLING, GOBLIN,"
8450 PRINT " HOBGOBLIN, ORCISH, GNOLL, THEIR ALIGNMENT TONGUE, AND THE COMMON"
8460 PRINT " TONGUE.  THEY HAVE INFRAVISION AND CAN SEE 60' IN THE DARK"
8470 PRINT " ELVES HAVE A 1/6 CHANCE OF DETECTING SECRET DOORS JUST BY BEING"
8480 PRINT " WITHIN 10' OF THEM.  WHEN ACTIVELY LOOKING, THEY HAVE A 1/3"
8490 PRINT " CHANCE OF FINDING ONE AND 50% CHANCE OF FINDING A HIDDEN DOOR"
8500 PRINT " UNARMORED ELVES HAVE A 2/3 CHANCE OF SURPRISING MONSTERS IF NO"
8510 PRINT " DOOR NEED BE OPENED AND 1/3 IF THERE IS A DOOR"
8520 RETURN
8599 REM
8600 REM *** PRINT DWARF RACIAL DATA ***
8610 REM
8620 PRINT " DWARVES ARE NON-MAGICAL AND NEVER USE SPELLS.  BECAUSE OF THEIR"
8630 PRINT " EXCEPTIONAL CONSTITUTIONS, DWARVES SAVE AGAINST POISON AS THEY"
8640 PRINT " DO FOR WANDS, STAVES, RODS, OR SPELLS."
8650 PRINT " ALL DWARVES SPEAK DWARVEN, GNOME, GOBLIN, KOBOLD, ORCISH, THEIR"
8660 PRINT " ALIGNMENT TONGUE, AND THE COMMON LANGUAGE.  HOWEVER, THEY ARE"
8670 PRINT " UNABLE TO LEARN MORE THAN 2 ADDITIONAL LANGUAGES."
8680 PRINT " DWARVES HAVE INFRAVISION AND CAN SEE 60' IN THE DARK. "
8690 PRINT " DWARVES ARE MINERS AND, WHEN WITHIN 10', CAN DETECT A SLOPING"
8700 PRINT " PASSAGE (75%), NEW CONSTRUCTION (75%), SLIDING OR SHIFTING WALLS"
8710 PRINT " (66 2/3%), PIT TRAPS, FALLING BLOCK TRAPS, AND OTHER STONE WORK"
8720 PRINT " (50%), AND THEY MAY DETERMINE THEIR DEPTH UNDERGROUND 50% OF THE"
8730 PRINT " TIME REGARDLESS OF THEIR LOCATION"
8740 PRINT "  THEY HAVE +1 TO HIT AGAINST HALF-ORCS, GOBLINS, HOBGOBLINS OR"
8750 PRINT " ORCS.  WHEN DWARVES ARE ATTACKED BY OGRES, TROLLS, GIANTS, OR"
8760 PRINT " OTHER LARGE MONSTERS, SUBTRACT 4 FROM THE OPPONENTS HIT ROLLS"
8770 PRINT " BECAUSE OF THE DWARVES SMALL SIZE"
8780 RETURN
8799 REM
8800 REM *** ADJUST HIT POINTS (H6) BASED ON CONSTITUTION A(5) ***
8810 REM
8820 IF A(5)<4 THEN H6=H6-2
8830 IF A(5)=4 OR A(5)=5 OR A(5)=6 THEN H6 = H6-1
8840 IF A(5)=15 THEN H6 = H6+1
8850 IF A(5)>15 THEN H6 = H6+2
8860 IF C=1 AND A(5)>16 THEN H6 = H6+A(5)-16
8870 IF H6<1 THEN H6=1
8880 RETURN
8899 REM
8900 REM *** PRINT FIGHTER CLASS DATA ***
8910 REM
8920 PRINT " FIGHTERS CAN USE ANY MAGIC WEAPONS OR ARMOR, POTIONS, "
8930 PRINT " 'PROTECTION' SCROLLS, MANY RINGS, AND MANY OTHER MAGIC ITEMS"
8940 RETURN
8999 REM
9000 REM *** PRINT MAGIC USER CLASS DATA ***
9010 REM
```



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See your Apple dealer or contact Dakin5 Corporation, P. O. Box 21187, Denver, Colorado 80221. Telephone: (303) 426-6090.

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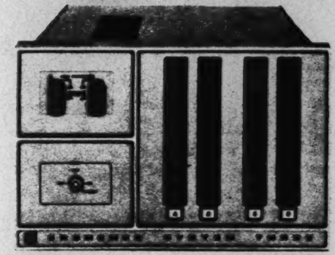

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CIRCLE 179 ON READER SERVICE CARD

```
9020 PRINT " MAGICIANS MAY WEAR NO ARMOR AND CAN USE FEW WEAPONS AS ALL OF"
9030 PRINT " THEIR TIME IS DEVOTED TO STUDY - NOT COMBAT TRAINING. "
9040 PRINT " THE FIRST SPELL ALL MAGIC USERS LEARN IS 'READ MAGIC' SO THAT"
9050 PRINT " THEY MAY STUDY SPELL BOOKS.  ALL SPELLS MUST BE SPOKEN ALOUD"
9060 PRINT " TO BE INVOKED AND THE MAGICIAN MUST RETURN TO HIS SPELL BOOK "
9070 PRINT " FOR MORE STUDY BEFORE HE CAN RE-CAST ANY GIVEN SPELL."
9080 PRINT " MAGIC USERS MAY USE ALL MAGICAL ITEMS INCLUDING WEAPONS."
9090 RETURN
9099 REM
9100 REM *** PRINT CLERIC CLASS DATA ***
9110 REM
9120 PRINT " THE CLERIC IS DEDICATED TO ONE OR MORE DIETIES AND HAS SOME"
9130 PRINT " SKILL AT ARMS HOWEVER THEY MAY NOT USE EDGED OR POINTED WEAPONS"
9140 PRINT " CLERICS MAY TURN AWAY THE UNDEAD INCLUDING GHASTS, GHOSTS, "
9150 PRINT " GHOULS, LICHES, MUMMIES, SHADOWS, SKELETONS, SPECTRES, WIGHTS,"
9160 PRINT " WRAITHS, VAMPIRES, AND ZOMBIES.  "
9170 PRINT " CLERICS MAY USE MOST POTIONS AND RINGS, ALL CLERICAL SCROLLS,"
9180 PRINT " AND MANY OTHER MAGIC ITEMS INCLUDING MAGIC ARMOR AND WEAPONS"
9190 PRINT " EXCEPT, OF COURSE, EDGED OR POINTED WEAPONS."
9195 RETURN
9199 REM
9200 REM *** PRINT THIEF CLASS DATA ***
9210 REM
9220 PRINT " MOST THIEVES TEND TOWARDS EVIL ALTHOUGH THEY MAY BE NEUTRAL"
9230 PRINT " OR VERY RARELY, GOOD.  THEY MAY BE LAWFUL OR CHAOTIC."
9340 PRINT " THIEVES MAINLY USE CUNNING OR STEALTH IN THEIR PURSUITS BUT"
9350 PRINT " THEY MAY WEAR LEATHER ARMOR AND CAN USE MANY WEAPONS THOUGH"
9360 PRINT " THEY ARE MORE LIKELY TO STAB SOMEONE IN THE BACK THAN TO ENGAGE"
9370 PRINT " IN OPEN COMBAT"
9380 RETURN
9399 REM
9800 REM *** ERROR MESSAGES ON INPUT ***
9810 REM
9820 PRINT "   MAGIC USERS MUST BE HUMAN OR ELVEN"
9830 PRINT "   CLERICS MUST BE HUMAN OR HALF-ORCS"
9840 PRINT "   PLEASE TRY AGAIN "
9850 GOTO 620
9899 REM
9900 REM *** ROLL N D-SIDED DICE AND RETURN TOTAL IN T
9910 REM
9920 T = 0
9930 FOR K=1 TO N
9940 T = T+INT(RND(0)*D)+1
9950 NEXT K
9960 RETURN
10000 REM *** PRINT HALFLING RACIAL CHARACTERISTICS ***
10010 REM
10020 PRINT " HALFLINGS CAN SPEAK DWARVEN, ELVEN, GNOME, GOBLIN, HALFLING,"
10030 PRINT " ORCISH, THEIR ALIGNMENT TONGUE, AND THE COMMON TONGUE."
10040 PRINT " HALFLINGS WITH MIXED BLOOD HAVE INFRAVISION WHICH CAN SEE UP"
10050 PRINT " TO 30' IN THE DARK, WHILE HALFLINGS WITH PURE STOUTISH BLOOD"
10060 PRINT " HAVE A 60' INFRAVISION RANGE."
10070 PRINT "  THEY HAVE A 75% CHANCE OF DETECTING A SLOPING PASSAGE, AND"
10080 PRINT " CAN TELL IF IT IS UP OR DOWN 50% OF THE TIME."
10090 RETURN
10199 REM
10200 REM *** PRINT HALF-ORC DATA ***
10210 REM
10220 PRINT " HALF ORCS SPEAK ORCISH, THEIR ALIGNMENT TONGUE, THE COMMON"
10230 PRINT " TONGUE, AND MAY LEARN A MAXIMUM OF 2 OTHER LANGUAGES."
10240 PRINT " THEY HAVE INFRAVISION AND CAN SEE 60' IN THE DARK."
10250 RETURN
10299 REM
READY

RUN
THIS PROGRAM GENERATES CHARACTERS FOR TSR'S GAME OF
DUNGEONS AND DRAGONS.  YOU MAY GENERATE CHARACTERS OF ANY
VALID COMBINATION OF CLASS AND RACE FROM THE FOLLOWING TABLE
CLASS 1  FIGHTER      RACE 1 HUMAN
CLASS 2  MAGIC USER   RACE 2 ELF
CLASS 3  CLERIC       RACE 3 DWARF
CLASS 4  THIEF        RACE 4 HALFLING
                      RACE 5 HALF-ORC
ENTERING A 0,0 TERMINATES THE PROGRAM
ENTERING -1,-1 CAUSES THE INSTRUCTIONS TO REPEAT

WHEN REQUESTED, ENTER THE CLASS NUMBER, A COMMA, AND THE
RACE NUMBER THAT YOU DESIRE
GOOD LUCK ON YOUR ROLLS
ENTER CLASS, RACE NUMBERS 1,1
HUMAN VETERAN (FIGHTER)  NAME =                         SEX =

ALIGNMENT =

STRENGTH         14         INTELLIGENCE   16
WISDOM           14         DEXTERITY      14
CONSTITUTION     17         CHARISMA       14
HITS TO KILL     11   ( 1D 10)
WEALTH =  150 GP
HIT PROBABILITY NORMAL  DAMAGE ADJUSTMENT NONE  WEIGHT ALLOWANCE +200
  OPEN DOORS ON 1-2/6  BEND BARS/LIFT GRATES 7%
THE CHARACTER MAY LEARN  5 ADDITIONAL LANGUAGES

HUMANS ARE CONSIDERED 'NORMAL' IN THIS WORLD AND HAVE
NO SPECIAL ABILITIES

FIGHTERS CAN USE ANY MAGIC WEAPONS OR ARMOR, POTIONS,
'PROTECTION' SCROLLS, MANY RINGS, AND MANY OTHER MAGIC ITEMS
2,2
ELVEN PRESTIDIGITATOR (MAGICIAN)  NAME =                          SEX =

ALIGNMENT =

STRENGTH         17         INTELLIGENCE   13
WISDOM           15         DEXTERITY      11
CONSTITUTION     14         CHARISMA       15

HITS TO KILL     1   ( 1D 4)

WEALTH =  40 GP
HIT PROBABILITY +1  DAMAGE ADJUSTMENT +1  WEIGHT ALLOWANCE +500
  OPEN DOORS ON 1-3/6  BEND BARS/LIFT GRATES 13%
 THE CHARACTER MAY LEARN  3 ADDITIONAL LANGUAGES
CHARACTER HAS A  55% CHANCE TO KNOW FROM  6 TO  9 SPELLS
ELVES HAVE A 90% RESISTANCE TO SLEEP AND CHARM SPELLS
ELVES HAVE +1 TO HIT WHEN USING SWORDS OR ANY BOWS EXCEPT
CROSSBOWS.  THEY MAY SPEAK ELVISH, GNOME, HALFLING, GOBLIN,
HOBGOBLIN, ORCISH, GNOLL, THEIR ALIGNMENT TONGUE, AND THE COMMON
TONGUE.  THEY HAVE INFRAVISION AND CAN SEE 60' IN THE DARK
ELVES HAVE A 1/6 CHANCE OF DETECTING SECRET DOORS JUST BY BEING
WITHIN 10' OF THEM.  WHEN ACTIVELY LOOKING, THEY HAVE A 1/3
CHANCE OF FINDING ONE AND 50% CHANCE OF FINDING A HIDDEN DOOR
UNARMORED ELVES HAVE A 2/3 CHANCE OF SURPRISING MONSTERS IF NO
DOOR NEED BE OPENED AND 1/3 IF THERE IS A DOOR
MAGICIANS MAY WEAR NO ARMOR AND CAN USE FEW WEAPONS AS ALL OF
THEIR TIME IS DEVOTED TO STUDY - NOT COMBAT TRAINING.
THE FIRST SPELL ALL MAGIC USERS LEARN IS 'READ MAGIC' SO THAT
THEY MAY STUDY SPELL BOOKS.  ALL SPELLS MUST BE SPOKEN ALOUD
TO BE INVOKED AND THE MAGICIAN MUST RETURN TO HIS SPELL BOOK
FOR MORE STUDY BEFORE HE CAN RE-CAST ANY GIVEN SPELL.
 MAGIC USERS MAY USE ALL MAGICAL ITEMS INCLUDING WEAPONS.

ENTER CLASS, RACE NUMBERS 3,5
```

ACTION, STRATEGY, AND FANTASY

for the SERIOUS games player

Brain Games - 1 demands ingenuity.

Two players bombard radioactive material with protons and electrons until it reaches critical mass and sets up a ***Nuclear Reaction. Dodgem*** *requires you to outmaneuver another player to get your pieces across the board first.* ***Dueling Digits*** *and* ***Parrot*** *challenges your ability to replicate number and letter sequences.* ***Tones*** *lets you make music with your Apple (16K) CS-4004 $7.95.* ***Strategy Games*** *and* ***Brain Games*** *are on one disk (16K) CS-4503 $14.95.*

THINK

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You're in command in *Space Games - 1.*

Maneuver the TIE fighters into your blaster sights and zap them with your lasers to save the rebel base camp from annihilation in ***Star Wars. Rocket Pilot*** *is an advanced real time take off and landing game. High resolution graphics, exploding saucers and sound effects add to the suspense as you repel the* ***Saucer Invasion.*** *Finally, a bonus graphics demonstration,* ***Dynamic Bouncer*** *(16K) CS-4001 $7.95.* ***Space Games*** *and* ***Sports Games*** *are on one disk (16K) CS-4501 for $14.95*

ACTION

Sports Games - 1 puts you in the Apple World Series

Take the field in the ***Great American Computer Game.*** *Mix up your pitches to keep the batter off balance. Move your fielders to snag the ball before he gets to first. Balls and strikes, double plays, force outs, and errors let you play with a realistic strategy. Also in the line up—* ***Slalom,*** *a championship downhill ski race,* ***Torpedo Alley,*** *and* ***Darts*** *(16K) CS-4002 $7.95.* ***Space Games*** *and* ***Sports Games*** *are on one disk (16K) CS-4501 for $14.95*

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```
HALF-ORC ACOLYTE (CLERIC)  NAME =                     SEX =
ALIGNMENT =
STRENGTH          17        INTELLIGENCE   15
WISDOM            14        DEXTERITY      11
CONSTITUTION      16        CHARISMA       12
HITS TO KILL       9   ( 1D 8)
WEALTH =  130 GP
HIT PROBABILITY +1  DAMAGE ADJUSTMENT +1  WEIGHT ALLOWANCE +500
  OPEN DOORS ON 1-3/6  BEND BARS/LIFT GRATES 13%
THE CHARACTER MAY LEARN  4 ADDITIONAL LANGUAGES
HALF ORCS SPEAK ORCISH, THEIR ALIGNMENT TONGUE, THE COMMON
TONGUE, AND MAY LEARN A MAXIMUM OF 2 OTHER LANGUAGES.
THEY HAVE INFRAVISION AND CAN SEE 60' IN THE DARK.

THE CLERIC IS DEDICATED TO ONE OR MORE DIETIES AND HAS SOME
SKILL AT ARMS HOWEVER THEY MAY NOT USE EDGED OR POINTED WEAPONS
CLERICS MAY TURN AWAY THE UNDEAD INCLUDING GHASTS, GHOSTS,
GHOULS, LICHES, MUMMIES, SHADOWS, SKELETONS, SPECTRES, WIGHTS,
WRAITHS, VAMPIRES, AND ZOMBIES.
CLERICS MAY USE MOST POTIONS AND RINGS, ALL CLERICAL SCROLLS,
AND MANY OTHER MAGIC ITEMS INCLUDING MAGIC ARMOR AND WEAPONS
EXCEPT, OF COURSE, EDGED OR POINTED WEAPONS.
4,4
HALFLING ROGUE (THIEF)  NAME =                     SEX =

ALIGNMENT =
STRENGTH          14        INTELLIGENCE   13
WISDOM            16        DEXTERITY      15
CONSTITUTION      12        CHARISMA       17
HITS TO KILL       4   ( 1D 6)

WEALTH =  80 GP
HIT PROBABILITY NORMAL  DAMAGE ADJUSTMENT NONE  WEIGHT ALLOWANCE +200
  OPEN DOORS ON 1-2/6  BEND BARS/LIFT GRATES 7%

 THE CHARACTER MAY LEARN  3 ADDITIONAL LANGUAGES
HALFLINGS CAN SPEAK DWARVEN, ELVEN, GNOME, GOBLIN, HALFLING,
ORCISH, THEIR ALIGNMENT TONGUE, AND THE COMMON TONGUE.
HALFLINGS WITH MIXED BLOOD HAVE INFRAVISION WHICH CAN SEE UP
TO 30' IN THE DARK, WHILE HALFLINGS WITH PURE STOUTISH BLOOD
HAVE A 60' INFRAVISION RANGE.
 THEY HAVE A 75% CHANCE OF DETECTING A SLOPING PASSAGE, AND
CAN TELL IF IT IS UP OR DOWN 50% OF THE TIME.
MOST THIEVES TEND TOWARDS EVIL ALTHOUGH THEY MAY BE NEUTRAL
OR VERY RARELY, GOOD.  THEY MAY BE LAWFUL OR CHAOTIC.
THIEVES MAINLY USE CUNNING OR STEALTH IN THEIR PURSUITS BUT
THEY MAY WEAR LEATHER ARMOR AND CAN USE MANY WEAPONS THOUGH
THEY ARE MORE LIKELY TO STAB SOMEONE IN THE BACK THAN TO ENGAGE
IN OPEN COMBAT
ENTER CLASS, RACE NUMBERS 1,3
DWARVEN VETERAN (FIGHTER)  NAME =                     SEX =

ALIGNMENT =
STRENGTH          16        INTELLIGENCE   12
WISDOM            18        DEXTERITY      16
CONSTITUTION      14        CHARISMA       13
HITS TO KILL       6   ( 1D 10)
WEALTH =  90 GP
HIT PROBABILITY NORMAL  DAMAGE ADJUSTMENT +1  WEIGHT ALLOWANCE +350
  OPEN DOORS ON 1-3/6  BEND BARS/LIFT GRATES 10%
THE CHARACTER MAY LEARN  3 ADDITIONAL LANGUAGES
DWARVES ARE NON-MAGICAL AND NEVER USE SPELLS.  BECAUSE OF THEIR
EXCEPTIONAL CONSTITUTIONS, DWARVES SAVE AGAINST POISON AS THEY
DO FOR WANDS, STAVES, RODS, OR SPELLS.
ALL DWARVES SPEAK DWARVEN, GNOME, GOBLIN, KOBOLD, ORCISH, THEIR
ALIGNMENT TONGUE, AND THE COMMON LANGUAGE.  HOWEVER, THEY ARE
UNABLE TO LEARN MORE THAN 2 ADDITIONAL LANGUAGES.
DWARVES HAVE INFRAVISION AND CAN SEE 60' IN THE DARK.
DWARVES ARE MINERS AND, WHEN WITHIN 10', CAN DETECT A SLOPING
PASSAGE (75%), NEW CONSTRUCTION (75%), SLIDING OR SHIFTING WALLS
(66 2/3%), PIT TRAPS, FALLING BLOCK TRAPS, AND OTHER STONE WORK
(50%), AND THEY MAY DETERMINE THEIR DEPTH UNDERGROUND 50% OF THE
TIME REGARDLESS OF THEIR LOCATION
 THEY HAVE +1 TO HIT AGAINST HALF-ORCS, GOBLINS, HOBGOBLINS OR
ORCS.  WHEN DWARVES ARE ATTACKED BY OGRES, TROLLS, GIANTS, OR
OTHER LARGE MONSTERS, SUBTRACT 4 FROM THE OPPONENTS HIT ROLLS
BECAUSE OF THE DWARVES SMALL SIZE
FIGHTERS CAN USE ANY MAGIC WEAPONS OR ARMOR, POTIONS,
'PROTECTION' SCROLLS, MANY RINGS, AND MANY OTHER MAGIC ITEMS
1,6
THIS PROGRAM GENERATES CHARACTERS FOR TSR'S GAME OF
DUNGEONS AND DRAGONS.  YOU MAY GENERATE CHARACTERS OF ANY
VALID COMBINATION OF CLASS AND RACE FROM THE FOLLOWING TABLE
CLASS 1  FIGHTER        RACE 1 HUMAN
CLASS 2  MAGIC USER     RACE 2 ELF
CLASS 3  CLERIC         RACE 3 DWARF
CLASS 4  THIEF          RACE 4 HALFLING
                        RACE 5 HALF-ORC
ENTERING A 0,0 TERMINATES THE PROGRAM
ENTERING -1,-1 CAUSES THE INSTRUCTIONS TO REPEAT
WHEN REQUESTED, ENTER THE CLASS NUMBER, A COMMA, AND THE
RACE NUMBER THAT YOU DESIRE
GOOD LUCK ON YOUR ROLLS
ENTER CLASS, RACE NUMBERS 2,3
   MAGIC USERS MUST BE HUMAN OR ELVEN
   CLERICS MUST BE HUMAN OR HALF-ORCS
   PLEASE TRY AGAIN
ENTER CLASS, RACE NUMBERS 3,5


HALF-ORC ACOLYTE (CLERIC)  NAME =                     SEX =

ALIGNMENT =

STRENGTH          16        INTELLIGENCE   13
WISDOM            13        DEXTERITY      10
CONSTITUTION      18        CHARISMA       12

HITS TO KILL       7   ( 1D 8)
WEALTH =  90 GP

HIT PROBABILITY NORMAL  DAMAGE ADJUSTMENT +1  WEIGHT ALLOWANCE +350
  OPEN DOORS ON 1-3/6  BEND BARS/LIFT GRATES 10%

 THE CHARACTER MAY LEARN  3 ADDITIONAL LANGUAGES

 HALF ORCS SPEAK ORCISH, THEIR ALIGNMENT TONGUE, THE COMMON
 TONGUE, AND MAY LEARN A MAXIMUM OF 2 OTHER LANGUAGES.
 THEY HAVE INFRAVISION AND CAN SEE 60' IN THE DARK.

 THE CLERIC IS DEDICATED TO ONE OR MORE DIETIES AND HAS SOME
 SKILL AT ARMS HOWEVER THEY MAY NOT USE EDGED OR POINTED WEAPONS
 CLERICS MAY TURN AWAY THE UNDEAD INCLUDING GHASTS, GHOSTS,
 GHOULS, LICHES, MUMMIES, SHADOWS, SKELETONS, SPECTRES, WIGHTS,
 WRAITHS, VAMPIRES, AND ZOMBIES.
 CLERICS MAY USE MOST POTIONS AND RINGS, ALL CLERICAL SCROLLS,
 AND MANY OTHER MAGIC ITEMS INCLUDING MAGIC ARMOR AND WEAPONS
 EXCEPT, OF COURSE, EDGED OR POINTED WEAPONS.

ENTER CLASS, RACE NUMBERS 3,4
   MAGIC USERS MUST BE HUMAN OR ELVEN
   CLERICS MUST BE HUMAN OR HALF-ORCS
   PLEASE TRY AGAIN
ENTER CLASS, RACE NUMBERS 0,0
STOP IN LINE 640
READY
```

DRAGON

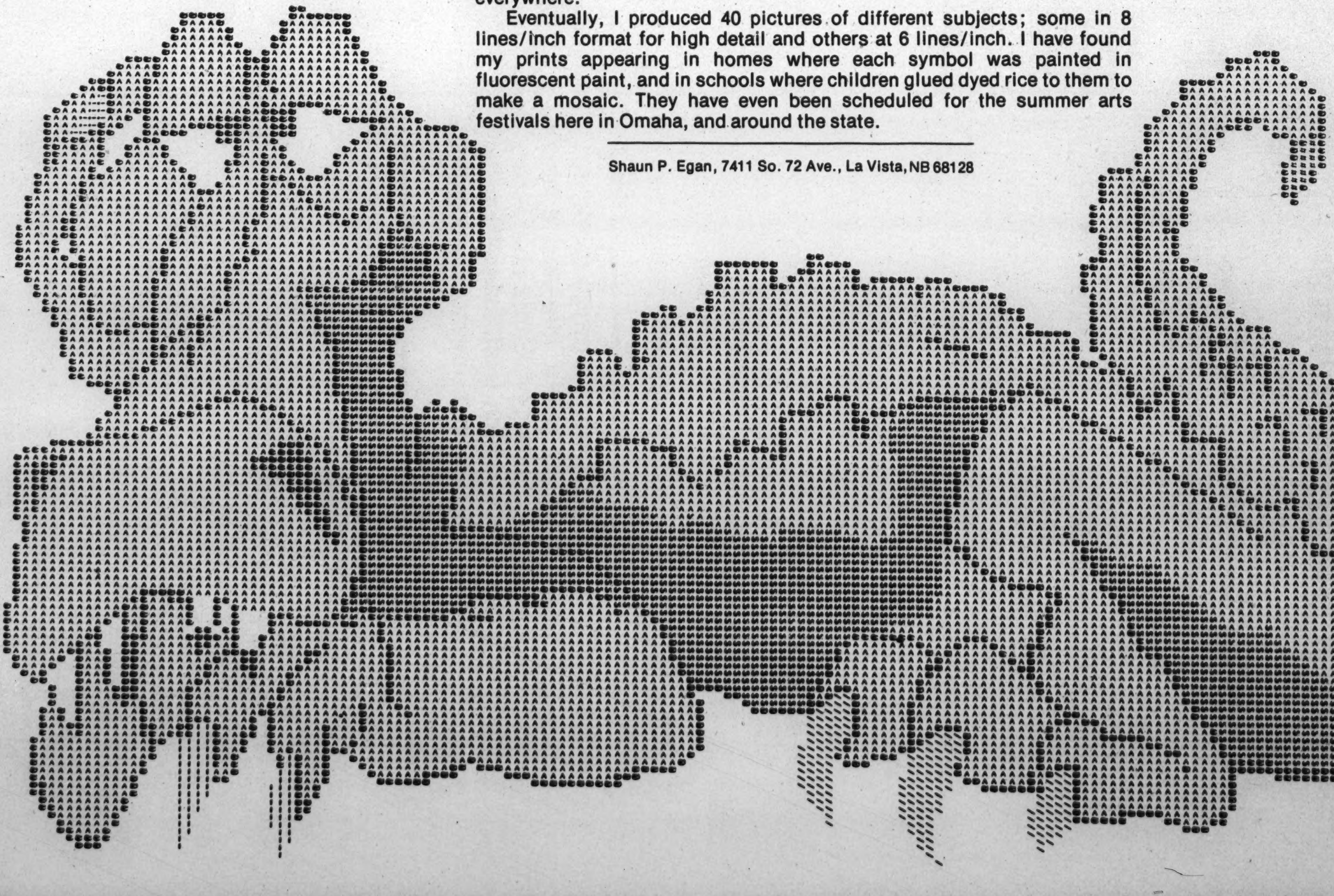
Shaun P. Egan

In early 1977 a friend gave me a printout of the USS Enterprise that fascinated me so much that I spent 90 hours putting it on our computer. Since I work for the 4000th Aerospace Applications Group, Offutt AFB, Nebraska, I had little trouble in finding people who wanted copies.

When Star Wars first appeared at movie theaters, I dropped the idea of reproducing other Star Trek prints and began plans for several scenes from the Star Wars movie. As the job became easier, I also began work on Battlestar Galactica pictures. The biggest one, of the Battlestar Galactica, took over 170 hours of total time to create. Requests for prints came from everywhere.

Eventually, I produced 40 pictures of different subjects; some in 8 lines/inch format for high detail and others at 6 lines/inch. I have found my prints appearing in homes where each symbol was painted in fluorescent paint, and in schools where children glued dyed rice to them to make a mosaic. They have even been scheduled for the summer arts festivals here in Omaha, and around the state.

Shaun P. Egan, 7411 So. 72 Ave., La Vista, NB 68128



How to Fit a Large Program Into a Small Machine

or

How to fit the Great Underground Empire on your desk-top

Marc S. Blank
and
S. W. Galley

WELCOME
TO
ZORK

As a rule, "sophisticated" programming is pretty boring — optimizing the unnecessary to speed up the uninteresting. Here, however, is an incredibly sophisticated package intended for fun and games. The more you know about software, the more astounded you will become as you read this.

Imagine yourself sitting down at your favorite personal computer, inserting a diskette, turning on the power, and seeing what follows. Your typed replies are in capital letters.

```
Zork: The Great Underground Empire part 1, release 1
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West of House
    You are standing in an open field west of a white house, with a boarded front door.
    A rubber mat saying 'Welcome to Zork!' lies by the door.
    There is a small mailbox here.
>OPEN THE SMALL MAILBOX
    Opening the mailbox reveals a leaflet.
>READ THE LEAFLET
(Taken)
    Welcome to Zork: The Great Underground Empire
    Zork: The Great Underground Empire is a game of adventure, danger, and low cunning. In it you will explore some of the most amazing territory ever seen by mortals.
    No computer should be without one!
```

Z-code strings work out to about five and a half bits per visible character, which is still significantly more compact than eight bits.

```
    The original ZORK was created by Tim Anderson, Marc Blank, Bruce Daniels, and Dave Lebling. It was inspired by the ADVENTURE game of Crowther and Woods. This version was created by Marc Blank, Dave Lebling, Joel Berez, and Scott Cutler.
>WALK AROUND THE HOUSE
North of House
    You are facing the north side of a white house. There is no door here, and all the windows are boarded up. To the north a narrow path winds through the trees.
>AGAIN
Behind House
    You are behind the white house. A path leads into the forest to the east. In one corner of the house there is a small window which is slightly ajar.
>LOOK IN THE WINDOW
    You can see what appears to be a kitchen.
>GO IN
    The kitchen window is closed.
>OPEN IT
    With great effort, you open the window far enough to allow entry.
>GO IN
Kitchen
    You are in the kitchen of the white house. A table seems to have been used recently for the preparation of food. A passage leads to the west and a dark staircase can be seen leading upward. A dark chimney leads down and to the east is a small window which is open.
    On the table is an elongated brown sack, smelling of hot peppers. A bottle is sitting on the table.
    The glass bottle contains:
A quantity of water
>PICK UP
pick up what?
>ALL BUT THE SACK
kitchen table: An interesting idea . . .
glass bottle: Taken.
quantity of water: I can't reach that.
>GO WEST
Living Room
    You are in the living room. There is a door to the east, a wooden door with strange gothic lettering to the west, which appears to be nailed shut, and a large oriental rug in the center of the room.
    There is a trophy case here. A battery-powered brass lantern is on
```

Marc S. Blank, 2315 Stearns Hill Rd., Waltham, MA 02154, and S. W. Galley, 285 Gray St., Arlington, MA 02174.

ALMOST PERFEC.

The MAGiC WAND™ is the most powerful, most flexible, most reliable, *most usable* word processing software available for a CP/M®-based computer.

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The MAGIC WAND *is* the best word processing software ever written for a microcomputer. It can do more work in less time with higher quality than any other product you can buy.

The MAGIC WAND is a rock solid piece of software. The command structure is simple and logical and complete. We have not tossed in features without thought to the overall design of the package. Nor have we included any feature that is not thoroughly implemented. The programs are crash-proof and completely reliable.

And the system is supported by what we are told is the best user's manual ever produced for microcomputer software. It contains a step-by-step instructional program designed for the novice. The trainee uses sample files from the system disk and compares his work to simulated screens and printouts in the manual.

Support doesn't stop when you buy the package. As a registered user, you receive our bi-monthly newsletter which answers questions, reports upgrades and teaches new applications of the MAGIC WAND.

It's through a lot of hard work that we are able to offer you a product that is "almost perfect," but we aren't about to stop working until we can say that the MAGIC WAND *is* perfect.

Full screen text editing

The MAGIC WAND has probably the most responsive and easy-to-use editor available for either a serial or DMA terminal. It uses only single stroke control keys to give command and takes advantage of the special function keys on your terminal whenever possible. In addition, you can set up library files with coded sections that you can merge by section name.

Full text formatting commands

The MAGIC WAND allows you to set the left, right, top and bottom margins, page length, indentation, paragraph indentation, (incuding "hanging" paragraphs), text left flush, right flush, justified (two ways), literal or centered, variable line and pitch settings, variable spacing (including half lines), bold face, underlining (solid or broken), conditional hyphenation, sub- and superscripting. You may change any of these commands at run-time *without reformatting the file.*

Merging with external data files

You may access any external data file, with either fixed length or sequential records. The MAGIC WAND converts the record into variables that you define and can use like any other variable. Of course, you may use the data for automatic form letter generation. But you can also use it for report generation.

Variables

You may define up to 128 variables with names of up to seven characters. The current value of a variable may be up to 55 characters, and you may print it at any point in the text without affecting the current format. Although the MAGIC WAND stores the variables as strings, you may also treat them as integer numbers or format them with commas and a decimal point. You may increment or decrement numeric variables or use them in formatting commands.

Conditional commands

You may give any print command based on a run-time test of a pre-defined condition. The conditional test uses a straightforward IF statement, which allows you to test any logical condition of a variable. You may skip over unneeded portions of the file, select specific records to print, store more than one document in a single file, etc.

True proportional printing

The MAGIC WAND supports proportional print elements on NEC, Diablo and Qume printers. Other formatting commands, including justified columns, boldface, underline, etc., are fully functional while using proportional logic.

Available on 8" soft-sectored and 5 1/4" Northstar or Micropolis (hard or soft sectored) diskettes, as well as ONYX hard disk. Terminals supported include—ADDS, Beehive, Cromemco, Dynabyte, Hazeltine, Heath, Imsai, Intertec, Lear Siegler, Microterm Act V, Perkin Elmer, Sol VDM1, Soroc, TEC, TEI, Televideo, TRS80 Mod II, Vector Graphics, plus a variety of video boards.

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How to, cont'd...

the trophy case. Above the trophy case hangs an elvish sword of great antiquity.

This transcript shows the beginning of an adventure into a land of Zork. Zork was originally a single "computerized fantasy simulation" game in which the object is to explore a labyrinth, called the Great Underground Empire, comprising a variety of interesting caves or rooms, and to find hidden treasures and return safely with them. We now say that Zork is a computer-game environment in which different games, with different scenarios and different puzzles to solve, can be written. A Zork player converses with a Zork program by typing commands in a kind of restricted English and reading the program's English responses. A longer description of the original game and program can be found in "Zork: A Computerized Fantasy Simulation Game" by Lebling, Blank, and Anderson (IEEE Computer, April 1979, pp. 51-59).

Status bits represent qualities of a Thing, both permanent (edible, burnable, fightable, "room," etc.) and temporary ("lit," "open," etc.).

The original Zork game was implemented on a DECsystem-10 at the MIT Laboratory for Computer Science in a local Lisp-like language called MDL. This Zork game was later translated into a Fortran version for DEC PDP-11 computers and made available through the DECUS program library. In both versions the program is large: it occupies most of a process's virtual storage on a 10, and it requires a large disk for secondary storage on an 11. In converting Zork to run on personal computers, the designers needed some way to shrink it in order to fit it into the relatively small available storage.

One shrinking tactic was to remove the features of MDL that are not needed in Zork, such as coroutines, associative storage, and fancy input/output. The stripped-down version of MDL that resulted was named Zork Implementation Language (ZIL). However, that was not enough: a straightforward compilation of a ZIL version of the original Zork game into the machine language of any known personal computer would still have produced an executable program too large to fit.

The solution was to invent a "virtual machine," specifically designed to execute Zork programs; the virtual "Z-machine" has a machine language called "Z-code," in which Zork programs can be expressed very compactly. Then all that was needed was a Zork Interpretive Program (ZIP), written in the machine language of any given target personal computer, that would imitate a Z-machine in carrying out the Z-code operations. (A compiler that translates from ZIL to Z-code is also needed, of course, but the highly-structured nature of MDL, and hence ZIL, makes that a relatively simple task.) A good benchmark for the storage saved by rewriting Zork in ZIL is the Zork parser, which analyzes a player's English input: the parser for the PDP-10 occupies 10K 36-bit words, while the Z-code parser, which is actually better functionally, occupies only 3K 8-bit bytes.

This Z-code approach is similar to that of compiling a Pascal program into "P-code," (although there are now P-code machines, like Western Digital's Pascal Microengine™, that are real and not just virtual). In effect, Z-code is like P-code: a string of subprogram calls, with the bodies of the subprograms executed by a Z-machine or ZIP. Any often-used sequence of operations in Zork programs could, in principle, be compressed into a Z-code instruction, thereby moving the sequence of operations into the Z-machine or ZIP, where it needs to appear only once. The Z-machine designer just has to be judicious in choosing Z-code bit patterns and subprogram parametrizations to get the most benefit from this virtual-machine method.

Besides compressing the space needed by Zork programs, the Z-code approach also makes conversion to another (real) computer easier, because, assuming that the design of Z-code is reasonably machine-independent, all one needs to do is to implement ZIP on the new machine.

Z-code objects:

Z-code is an object-oriented language (as are Lisp and MDL and ZIL). In this section the various kinds of objects and the possible operations on them are described. Excerpts from a transcript of a game are used to illustrate the uses of these objects.

All Z-code objects occupy one or two bytes in storage, and exactly two bytes while they are being processed. Like MDL, ZIL uses "type codes" to distinguish among the different types of objects, but Z-code does not, to save space; the ZIL compiler checks for proper use of types, but ZIP doesn't bother. A Z-code operation that yields a truth-value (integer 0 or 1) is called (as in Lisp) a "predicate"; the Z-code operation-codes for all predicates include a bit for inverting the sense of the test, another space-saving measure.

```
Dam Lobby
    This room appears to have been the waiting room for groups touring the dam. There are exits here to the north and east marked 'Private,' though the doors are open, and an exit to the south.
    Some guidebooks entitled 'Flood Control Dam #3' are on the reception desk. There is a matchbook whose cover says 'Visit Beautiful FCD#3' here.
>COUNT MATCHES
You have 5 matches.
>COUNT NOSES
I don't know the word 'noses.'
```

Integer:

An integer, such as the number of matches left in a matchbook, is stored in two bytes, according to the normal bit-level representation used by the hardware. Operations on integers include the four normal arithmetic functions, remainder or modular reduction, and generation of a random integer in the range 1-N. (Modular reduction — calculating the remainder in a division — is useful for stepping through a set of English responses cyclically. Random-integer generation is useful for choosing a response at random from a set of similar responses.) Predicates test for one integer being less than, greater than, or equal to another integer, and for an integer being zero. (Since the sense of a test can be reversed using one of the bits in its operation code, this means implicitly that there are also predicates to test for greater-than-or-equal, less-than-or-equal, not-equal, and not-zero.) Testing for zero may seem redundant, given an equality test, but it is used often enough that the cost of using another operation code is outweighed by the value of eliminating the byte that would be used to hold a zero in every instance. Naturally, there is an operation to "print" an integer in the output stream — though, of course most personal computers display characters on a CRT rather than printing them on paper.

In some situations an integer is treated as a string of 16 independent bits; for this case there are operations for Boolean "and" and "or" and "not," and for testing individual bits. The characters in the player's input are also stored as integers, using the ASCII code; for this case there is an output operation to print a single character, as shown in the last response above.

```
The Troll Room
    This is a small room with passages to the east and south and a forbidding hole leading west. Bloodstains and deep scratches (perhaps made by an axe) mar the walls.
    A nasty-looking troll, brandishing a bloody axe, blocks all passages out of the room.
    Your sword has begun to glow very brightly.
>KILL TROLL WITH KNIFE
    The blow lands, making a shallow gash in the troll's arm! The troll swings his axe, and it nicks your arm as you dodge.
>AGAIN
    The quickness of your thrust knocks the troll back, stunned. The troll slowly regains his feet.
>AGAIN
    A quick stroke, but the troll is on guard. The troll swings his axe, but it misses.
>AGAIN
    A good slash, but it misses the troll by a mile. The axe crashes against the rock, throwing sparks!
>AGAIN
    The troll is disarmed by a subtle feint past his guard. The troll, now worried about this encounter, recovers his bloody axe.
```

The name of a Thing identifies it uniquely to the player throughout the whole game, e.g., "kitchen," "bottle," "thief."

String:

As you can see, Zork programs tend to be wordy, so strings of characters need to be stored as compactly as possible. Three characters can fit in two bytes, if each character uses only five bits. But five bits can encode only 32 characters directly, and that is obviously not enough. The solution is to use different "contexts" and to reserve one or more "characters" for switching among contexts. (This technique is similar to the five-bit Baudot code, which was used by early Teletypes before ASCII was invented.) Z-code strings use three contexts — lower case, upper case, and digits/punctuation — and several characters for switching among the contexts, either "permanently" or only for the next character, the latter in order to capitalize a word or use a single punctuation mark. Because of the extra characters used to switch contexts, Z-code strings work out to about five and a half bits per visible character, which is still significantly more compact than eight bits.

The only operation on strings is to print them, i.e., show them to the player. There is no need to manipulate them, except to print strings sequentially so that they form sentences for the player. (Actually, simply because it occurs so often, there is also an operation for printing a string and then returning from a function call.) Most strings are stored without "new-line" characters, and ZIP takes care of "folding" the output into lines of a size convenient for the particular display being used; a few rigidly-formatted strings do use new-lines in order to draw a crude picture with the characters.

```
>SWIM
I don't really see how.
>SWIM
I think that swimming is best performed in water.
>SWIM
Perhaps it is your head that is swimming.
. . .
>TAKE HOUSE
What a concept!
>AGAIN
A valiant attempt.
>AGAIN
You can't be serious.
>AGAIN
Not bloody likely.
>AGAIN
An interesting idea . . .
```

Table:

A table is used to keep a set of related objects (like the responses above) together, as a list is used in Lisp or a record is used in Pascal. A table is stored as a number of two-byte (or sometimes one-byte) objects one after another. The length of a table is sometimes stored in its first element — to be used by parts of a program that need to step through all the elements — and sometimes not — if the program itself knows how long the table is. Operations on a table can get a word (two bytes) out of it and put a word into it; get a single byte out and put one in; and move the pointer along to another element (like CDR in Lisp) or backwards to a previous one (like BACK in MDL). (Actually, since a pointer to a table is just a plain address, ordinary addition and subtraction are used to move a pointer forward and backward in a table.)

Thing:

"Things" are probably the most interesting objects, since they represent the player, rooms, enemies, weapons, treasures and so on — the stuff of which a game is made. To avoid confusion, "Thing" will always be

No.14: Take a byte.

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SERIAL No.
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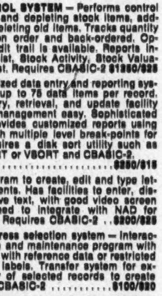

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How to, cont'd...

written with a capital "T" when it refers to this kind of Z-code object. Since there are relatively few Things used in a Zork game, but they are used very frequently, each Thing is designated by a one-byte number rather than, say, its two-byte address in storage. This design decision limits the number of possible Things in one game to 255, with the number zero reserved to mean "no Thing." (There are also "pseudo-Things", whose names the parser will recognize as significant but which have no interesting properties.)

A Thing's number can be easily translated into its address in storage, where its parts are found: status bits, contents, and properties. These parts are stored sequentially, as in a table, in a very strict format: four bytes for status, three bytes for contents, and two bytes holding the address of the property table — so ZIP needs to know only the address of the first Thing in order to translate a Thing number into its address.

Operations that do not deal directly with objects include the null operation, go-to (jump, branch), call a function, return a value to the calling function, return "true" or "false" or whatever is on top of the stack to the calling function.

Each Thing has 32 *status bits*, which can be turned off or on or tested individually by Z-code operations. Status bits represent qualities of a Thing, both permanent (edible, burnable, fightable, "room," etc.) and temporary ("lit," "open," etc.).

```
>TAKE SACK
Taken.
>LOOK IN SACK
The brown sack is closed.
>OPEN SACK
Opening the brown sack reveals a
lunch, and a clove of garlic.
>TAKE LUNCH OUT
Taken.
>TAKE CLOVE THEN PUT
BOTTLE IN SACK
Taken.
Done.
>LOOK IN SACK
The brown sack contains:
A glass bottle
The glass bottle contains:
  A quantity of water
```

How to, cont'd...

A Thing's *contents* part relates it spatially to other Things in three ways: as a parent ("container") as a child ("containee"), and as a sibling ("inmate"). For example, if the knife and the bottle are in the kitchen, then the kitchen's "child" slot would hold the number of the knife, the knife's "sibling" slot would hold the number of the bottle, and the knife's (and bottle's) "parent" slot would hold the number of the kitchen. (Of course, depending on how they got there, the knife and the bottle might be interchanged in this data structure.) Such a data structure is commonly called a list: Things can be added to or removed from a list simply by moving the appropriate numbers into the slots. Manipulating list structures of this kind — the reason Lisp was invented — is essential in Zork games, as Things get moved here and there by the player. For convenience, "contents" has a more general meaning in ZIL: for example, the player's baggage is "contained in" the player Thing. The operations on contents are

- "move X into Y,"
- "remove X from everything" (e.g., if it is eaten or otherwise destroyed),
- "is X in Y?" and "what is X in (if anything)?" (using X's parent slot),
- "what is the first Thing (if any) in X?" (using X's child slot), and
- "what is the next Thing (if any) in the same Thing that X is in?" (using X's sibling slot).

Program pages are kept on disk until needed and then read in to a suitable page frame for interpretation.

This is the attic. The only exit is a stairway leading down. On a table is a nasty-looking knife. A large coil of rope is lying in the corner.
>TAKE NASTY KNIFE
Taken.

. . .

Maze

This is part of a maze of twisty little passages, all alike.

A skeleton, probably the remains of a luckless adventurer, lies here. Beside the skeleton is a rusty knife.

The deceased adventurer's useless lantern is here. There is a skeleton key here. An old leather bag, bulging with coins, is here.

>TAKE RUSTY KNIFE

As you pick up the rusty knife, your sword gives a single pulse of blinding blue light.

Finally, each Thing has a table (in the format described previously) of its *properties*, such as name, size, capacity, score value, verbose description, north neighbor, synonyms, and action routines; the last can be seen in the transcript above involving the two knives. (The *name* of a Thing identifies it uniquely to the player throughout the whole game, e.g., "kitchen," "bottle," "thief." There is a special Z-code operation for printing a Thing's name.) Since there are a limited number of properties a Thing can have, and not all of them require the same amount of storage, a special format is used to store them in this table: the first byte of each property has a five-bit property number (allowing 32 different properties) and a three-bit count of the number of immediately following bytes used to store the property. The operations on properties are "get property Y of Thing X," "store Z as property Y of Thing X," "get the storage address of property Y of Thing X," and "get the next property of Thing X following this property."

>SCORE

Your score would be 10 (total of 375 points), in 9 moves. This score gives you the rank of Beginner.

Variable:

Variables are used to keep track of the situation all through the game. (Parts of Things are used also.) For example, the player's current score is a variable, called a "global" variable because it is the same no matter what functions have been called. Like Things, variables are identified by a one-byte number. A special number is used to identify the top of the "stack," and fifteen more numbers identify "local" variables used by the function currently executing. (The stack is described later.) The remaining 240 numbers identify global variables. Operations on variables store and retrieve the current value, increment or decrement an integer value by one and optionally test it for crossing a given threshold, push a value onto the stack, pop a value off the stack, and print the value.

Other operations:

The remaining Z-code operations do not deal directly with objects. These operations include the null operation, go-to (jump, branch), call a function, return a value to the calling function, and return "true" or "false", or whatever is on top of the stack to the calling function. Also there are special operations to input a line from the player and find the significant words in it using a vocabulary table, save the game situation on a disk or tape, restore a situation saved previously, quit playing or start afresh.

Z-code format:

Each Z-code instruction begins with a byte containing the operation code, which includes bits describing how the operands (or arguments) are addressed. Some operations always use a certain number of operands, and some operations use an unpredictable number of operands, from zero to four. Each operand that is used can be either a "small" (8-bit) integer, a "large"

(16-bit) integer, or a variable (8 bits). (A string is an operand for only one operation code, the print routine.) Following the operation-code byte are the operands. An operation that returns a value has another byte following the operands that tells in what variable to store the value. A predicate operation has another byte or two that tells where to go to, relative to this current instruction, if the predicate is true.

A subprogram is called with a special "call" operation code, whose operands are the address of the subprogram and the (zero to three) arguments or parameters for this call.

Z-code uses a single stack to store both temporary values and return addresses for pending function calls. Z-code doesn't distinguish between addresses and other kinds of data, but — because ZIL is a "structured" programming language — the ZIL compiler produces Z-code that uses the stack in a disciplined way, "pushing" and "popping" words in the correct order and not confusing one datum for another.

Storage management:

The address space of a personal computer running ZIP is divided into three parts: impure storage, resident pure storage, and non-resident pure storage. "Impure" means that the data in storage can be modified; impure storage is where all the Things, variables, stack, and so on live. To "save" the game situation just requires writing this part of storage onto a disk or tape, and to "restore" is the opposite; all other parts of the program are pure and unchanging, so they don't need to be saved.

Resident pure storage holds ZIP itself. "Resident" means that the code is loaded from disk at the start of execution and resides in primary memory throughout the game. Non-resident pure storage is paged (physical storage divided into page frames and Z-code program divided into pages, typically with 256 bytes each) and swapped (program pages are kept on disk until needed and then read in to a suitable page frame for interpretation). It may be necessary to swap in a page to read the next sequential byte (if the next byte lies on the next page) or during a go-to, call, return, or print-string Z-code instruction (if the target address lies on another page). Fortunately, the first situation is easy to test for, since the first byte of any page always has zeros for the least significant bits of the address; the second situation occurs infrequently and is easily handled by the parts of ZIP that interpret those instructions. ZIP keeps track of which pages are currently in which frames by using a page table, which holds the first virtual address of each page that is currently swapped in. ZIP must also translate addresses according to which frame currently holds which page.

We have described how a large program can be squeezed into a small machine by using a "virtual-machine" approach to encoding the program.

All the objects used by a Z-code program are set up in their proper locations and formats by the ZIL compiler. There is no need to create new objects while the Z-code program runs, and so there is no need to reclaim storage used by old objects with a Lisp-like garbage collector.

With ZIP needs to know to start running a game are the first address of the three parts of the address space; the first address of Thing storage, global-variable storage, and the vocabulary table used by the "input" Z-code instruction (whence it can find the number and size of vocabulary entries); and the address of the first executable instruction in the game.

Conclusion:

We have described how a large program can be squeezed into a small machine by using a "virtual-machine" approach to encoding the program. Essentially, the designers identified sub-programs within the large program (and within a whole series of similar programs) and chose ways to encode invocations of those sub-programs as compactly as possible. Then duplicate copies of those sub-programs could be removed, and the whole program could be encoded in the "machine language" of a virtual Z-machine. This technique follows a long line of tradition in computer programming that encourages identifying sub-programs and making them modular and easy to use.

Using this technique, versions of Zork games for personal computers such as Radio Shack TRS-80 and Apple have been developed by Infocom, Inc., P.O. Box 120, Kendall Station, Cambridge, MA 02142. For information about distribution and sales, contact Personal Software, Inc., 1330 Bordeaux Drive, Sunnyvale, CA 94086. ☐

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A New Kind Of Game

How to write An Adventure

Greg Hassett

As I gazed back at the crystal bridge that I had just crossed, I could hear water rushing nearby. My brass lantern was getting dim, and I knew that I would have to rest soon. The wisps of white mist danced before my eyes as if alive, and a sudden cold chill ran up my spine. I had with me a diamond necklace which I was determined to keep. A nasty dwarf emerged from the gloom. He threw a sharp knife at me! I grabbed my axe and heaved it at him. His body vanished in a cloud of greasy black smoke. My lamp was now out; I would have to search for batteries tomorrow in the dark. So I put my necklace in my small leather sack and called it a day.

I did not lie down on the cavern floor and go to sleep. I merely turned off my home computer. I had been playing a game called "Adventure." In this game, you explore a network of caves and pits in search of priceless treasure. This game is not the type of game which is mastered in an hour. It may take days, weeks, or even months to complete an Adventure.

This "original Adventure," developed at Stanford University a few years back by Willie Crowther and Don Woods, required large amounts of disk storage space. This made it very difficult to convert to run on a personal computer. However, other versions of Adventure have sprung up in the past year that are specifically designed to fit in the smaller machines.

To play Adventure, you enter commands to the computer in one or two word sentences in what seems to be English. A typical command might be "INSERT COIN" or "GET NECKLACE." To move about, you use commands such as "GO NORTH" or enter a new "location," a new room description will be displayed. An example of such a description might be:

I AM IN A RADIANT CAVERN FORTY FEET HIGH. THE WALLS AND FLOORS ARE MADE OF SMOOTH MARBLE. THE POOLS OF CLEAR WATER ON THE FLOOR INDICATE AN OPENING HIGH ABOVE ME. UP ON THE CEILING GLOWS AN EERIE RED LIGHT.

AROUND ME I SEE: POOLS OF WATER. SMALL PLASTIC VIAL.

Later on in the game, the vial might come in handy for holding some liquid etc., so in this situation it might be wise to "GET VIAL."

The one thing that I feel makes Adventuring so interesting is the clues that are given as you explore.

Knowing that clues exist is one thing; isolating them and figuring out what they mean is quite another. In Adventure, clues exist *everywhere.* They are in the room descriptions, the object descriptions. Let's say you enter a room where there are many stalactites, but no stalagmites on the floor. This in itself is a clue. If you think about it, stalagmites could be worn off if creatures lived there and walked through the cavern. But stalactites would not be destroyed because most creatures cannot reach them.

Then these are the type of clues which have to be decoded. As an example, take the clue "MAGIC BREAK WORD BOTTLE BIMBO." This clue makes no sense at first glance. But then you notice that if you read alternate words of the clue, it deciphers into "MAGIC WORD BIMBO" and "BREAK BOTTLE."

Magic words are very popular in Adventure. A common use for these words is movement. They might be the only way to get a completely different

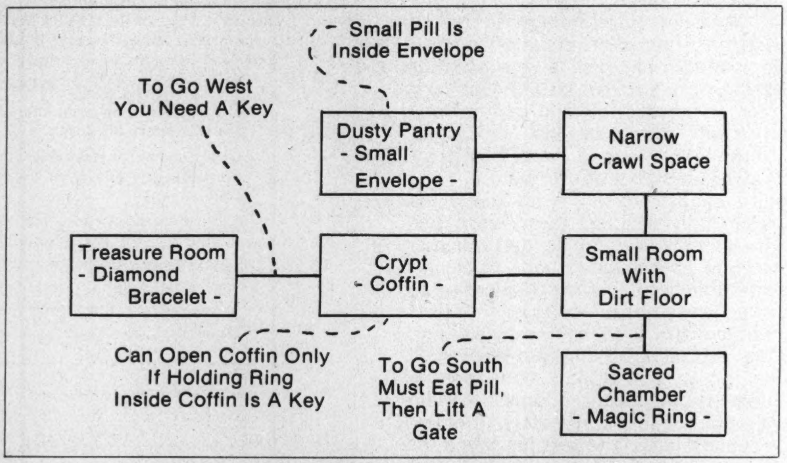
Small Pill Is Inside Envelope
To Go West You Need A Key
Dusty Pantry - Small Envelope -
Narrow Crawl Space
Treasure Room - Diamond Bracelet -
Crypt - Coffin -
Small Room With Dirt Floor
Can Open Coffin Only If Holding Ring Inside Coffin Is A Key
To Go South Must Eat Pill, Then Lift A Gate
Sacred Chamber - Magic Ring -

Figure 1: A typical portion of an Adventure map. Note that to get into the treasure room for the diamond bracelet, you must get the magic ring. To get the magic ring, you must eat the pill then lift a gate. To eat the pill, you must open the envelope found in the dusty pantry.

Greg Hassett, P.O. Box 914, No. Chelmsford, MA 01863.

area of the Adventure. One such example, in one Adventure the magic word "BIMBO" will magically take you from being lost in the maze of caves to a small jungle on the other side of the island. And there is no other way to get there.

In this way, Adventure is like a good mystery novel, with you being the ace detective. On the other hand, Adventure can be nerve-wracking, frustrating, and the source of serious insomnia! Adventure is a sort of puzzle . . . you have to fit *all* the pieces together to make it work.

I was first introduced to Adventure a few years back on a Digital Equipment Corporation PDP-11/70. I took an immediate liking to the game, but I didn't have any computer. When I purchased my Radio Shack TRS-80, I immediately set out to write an Adventure. The result was *Journey to the Center of the Earth*, my first. When I found out I could sell this, I wrote six other Adventures: *The House of Seven Gables*, *Entry into King Tut's Tomb*, *Sorcerer's Castle*, *Voyage to Atlantis*, *Enchanted Island*, and *Enchanted Island-Plus* (a machine-language version with additional features).

If there's one thing that's more habit-forming than playing Adventures, it's writing them.

Writing Adventures

In the following paragraphs, I will attempt to outline the basic structure of the way Adventure can be written in Basic.

The first step in writing a Basic Adventure is coming up with the plot. This means answering the questions:

"Where will the Adventure take place?"
"What will be the main purpose of the Adventure?"
"In what kind of world is this supposedly happening?"
"What types of obstacles will the player have to overcome?"
"How is the player gonig to get by these obstacles?"

Once these five questions are answered in your mind, you begin to draw the map of the Adventure. The general form of the map is shown in Figure 1. Once you have about 40 rooms (more if you are in machine language), you are ready to begin keying in the DATA. The way I do this is in the form:

line# DATA "room description",
n,e,s,w,u,d

where line# is the Basic statement number, "room description" is the description of the room, n is the room north of it, e is the room east of it, s is the room south of it, etc. If n,e,s,w,u, or d are set to zero, then there is no way to go from that room in the corresponding direction.

Each verb has its own special "verb routine" which is called after the parsing routine. For each verb, only a few nouns would make sense; for the "EAT" routine, "CHAIR" would have no meaning.

```
1000 'BASIC ROUTINE TO DISPLAY ROOM & ITS CONTENTS
1010 '
1020 'UPON ENTRY:
1030 '     CP=THE CURRENT PLACE IN THE ADVENTURE
1040 '     LO=THE MAXIMUM NUMBER OF OBJECTS IN THE ADVENTURE
1050 '     D$(1)="NORTH" , D$(2)="SOUTH" , D$(3)="EAST"
1060 '     D$(4)="WEST"  , D$(5)="UP"    , D$(6)="DOWN"
1070 '
1080 '
1090 CLS 'CLEAR SCREEN
1100 PRINT P$(CP) 'PRINT THE ROOM DESCRIPTION
1110 FOR I=1 TO LO 'THIS ROUTINE WILL PRINT ALL OBJECTS IN ROOM
1120 IF OB(I,0)=CP THEN PRINT OB$(I) 'IN ROOM? YES... PRINT IT
1130 NEXT I 'GO ON TO THE NEXT OBJECT
1140 FOR I=1 TO 6 'THIS ROUTINE WILL PRINT ALL POSSIBLE DIRECTIONS
1150 IF P(CP,I) <> 0 THEN PRINT D$(I) 'NOT ZERO? YES, PRINT D$(I)
1160 NEXT I 'GO ON TO NEXT DIRECTION
1170 PRINT STRING$(63,"-") 'PRINT BAR ACROSS SCREEN
1180 RETURN 'RETURN
```

Listing 1 — Basic listing of how the "display room" routine works. Note that all arrays must be set up as described in the text. The OB(x,0) array holds the room# of object x. Note line 1120 where this value is compared with the current room number. Each object is "tested" in this fashion.

The objects are set up somewhat differently. They are in the form:

line# DATA "object",(room),(value)

where line# is the Basic statement number, "object" is the description of the object, (room) is the room where the object resides at the start of the Adventure, and (value) [if the Adventure has treasures and points] is the number of points that the object is worth. If (room) is set to zero, then the object is currently nowhere. For instance, if a trap door is only revealed after the command "MOVE RUG" is executed, the starting room for the "TRAP DOOR" is zero. Later on, after the rug is moved, the trap door's room gets set to some number other than zero.

During the initial setup of the Adventure, the program READs all of this DATA into arrays P(x), P(x,y), OB$(x), and OB(x,y). P$(x) holds the room description of room x. P(x,y) holds the room adjacent to room x in direction y. Direction 1=North, direction 2=East, direction 3=South, direc-

HELPFUL TIPS FOR PLAYING ADVENTURE GAMES

If an Adventure is getting you *very* frustrated, the best thing to do is shut down the machine and try again a little bit later. If you are determined to get by the frustrating obstacle, call up a friend. He/she might have some ideas which you would never think of! If no friends are available, apply as much common sense as possible. If this fails as well, try obscure reasoning and make irrational decisions.

Watch out for any words in "quotes" or with *stars* around them. These usually are clues. Any clue can be figured out if enough thought is put into it. Try reversing all of the letters of a particular clue. It can transform something as obscure as "ARBADAC ARBA" into something meaningful like "ABRA CADABRA."

Remember that not every obstacle can be overcome! A window that cannot be opened or broken is probably just there to confuse the player. So, if it seems impossible to get by, it probably is.

Another reason why you may not be able to get by an obstacle is that you do not have the necessary resources! For instance, to break a window, you may need a hammer! If you have never encountered the hammer before, you may not even know that it exists, and you may spend more time trying to get by it *without* the hammer that you will spend *finding* the hammer!

Do not be afraid to try things that are seemingly stupid! In many cases a command that seems dumb turns out to be the way to overcome the obstacle.

Periodically (every 15 minutes or so) save your game out to tape or disk with the command "SAVE" or "SAVE GAME." This will insure that in the case of a fatal accident you only lose about 15 minutes Adventuring. Make absolutely *sure* that you save your game before trying things with unknown results, such as drinking strange bubbling liquids or jumping off a cliff.

Adventure, cont'd...

tion 4=West, direction 5=Up, and direction 6=Down. Also, after all of the room and object DATA has been read, the program proceeds to READ the vocabulary tables into arrays NO$(x) and VB$(x). The vocabulary is stored in this manner:

```
line# DATA noun1,noun2,noun3,
        noun4,...nounx
line#2 DATA verb1,verb2,verb3,
        verb4,...verbx
```

where line# and line#2 are Basic statement numbers, noun1-nounx are the vocabulary entries to be read into NO$(x) [nouns], and verb1-verbx are the vocabulary entries to be read into VB$(x) [verbs].

When the player enters a new room, the short routine in Listing 1 is executed. This will print the room description, its contents, and all possible directions leading out.

Parsing

Now that the Data Structure has been discussed, it becomes necessary to explain the parsing routine. This is the routine which will take the player's input, divide it into a verb/noun combination, compare it with the vocabulary tables, and return with two numbers, stored in the variables VB and NO, each representing the offset in the vocabulary array. For instance, let's assume that "EAT" is verb number 28 [VB$(28)="EAT"] and "CHAIR" is noun number 12 [NO$(12)="CHAIR"]. If the player inputs "EAT CHAIR" as his command, the parsing routine would get called, and upon return, NO would equal 12 and VB would equal 28. The main part of the program would then deal with these two numbers. Depending on the number stored in VB upon return from the parsing routine, the main part of the program would then jump to a verb routine.

If there's one thing that's more habit-forming than playing Adventures, it's writing them.

Verb Routines

Each verb has its own special "verb routine" which is called by a large ON GOTO statement executed after the parsing routine. For each verb, there are usually only a few nouns which would make sense. For instance, for the "EAT" routine, "CHAIR" would have no meaning. In all probability, only the noun "FOOD" would make any sense with "EAT." If any other noun was entered, the message "DON'T BE RIDICULOUS" would be output, and control would return to the input/parsing routine. If the noun *was* "FOOD," then the room# for the food would be set to zero [the food is non-existent once it has been eaten] and the message "MMM, GOOD." would be output. Control would then be transferred back to the input/parsing routine. ☐

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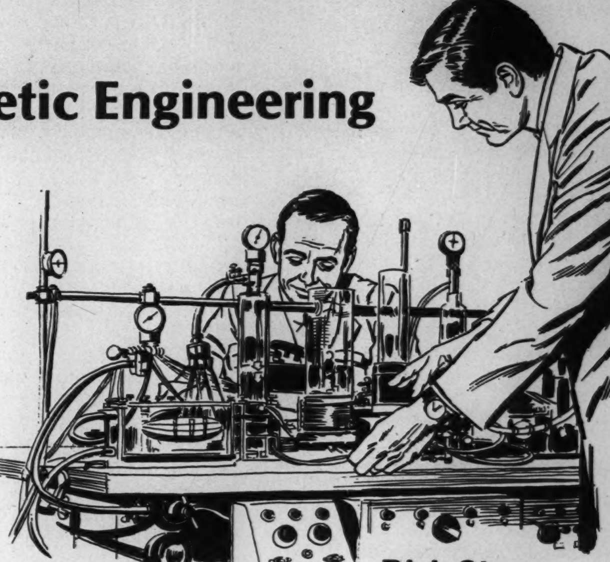
Genetic Engineering



Dick Straw

Have you ever thought you would like to be a genetic engineer? You know, someone with the skills and techniques to make plants and animals to your own designs? Or to eliminate some wasteful genetic disease by skillfully manipulating the hereditary material?

The means for accomplishing real genetic engineering are still not available, although biologists working in that field get closer and closer each year. With the CODON program that follows, you can simulate some of the hoped-for techniques, however, and get some ideas about how the genes do their work. If you happen to be a biology teacher, you can use the program to help students learn some of the basics of molecular biology as well.

The means for accomplishing real genetic engineering are still not available, although biologists get closer and closer each year.

Even if you are just an ordinary programming buff without much concern for genetic engineering or molecular biology, the CODON program might still be of interest to you because of the string-handling routines involved. They show off some important ways that the Basic language is, I feel, superior to Fortran, which handles strings only with difficulty. (Calm the hackles, friend — I use Fortran a lot too, when its advantages are needed!)

In addition, there is a segment that will direct all input and output to the printer without modifying the program to use LPRINT statements. (I owe this idea to Charles Butler, from an article in *Personal Computing.)*

This is not the place for an extended lesson in molecular biology. Almost all recent high school and college general biology books will give a good and more complete description of the details. A book called *Invitation to Biology* by Helena Curtis, used widely for college biology courses taken by non-specialists, is a good example. For a more detailed and superbly written account, try James Watson's (of double helix fame) book, *The Molecular Biology of the Gene.* Still, a very brief account might make the program more interesting.

Practically all the work of the cell is accomplished by proteins. These proteins are large and complex molecules made up of twenty elementary building blocks called amino acids. The numbers, kinds and order of the amino acids determine the shape and thus the function of the protein. Think of them, if you will, as factory "jigs" that hold things together so a needed chemical operation can be carried out. What molecules the proteins hold and what they do with them is determined entirely by the arrangement of their amino acids. Whether the cell or individual survives depends on what they do and how well, however.

Richard M. Straw, 2100 Maiden Lane, Altadena, CA 91001.

Genetic, cont'd...

What kinds of jigs the cellular factory makes is determined by the kinds of genes in the nucleus of the cell. You can think of genes as the specifications for building jigs. Every time a new factory (cell) is built, the jig-specifying genes are copied and passed on to it from the previous cell. Every time a new individual (a new person or flower, full of cell-factories) is produced, the cells in it get a portion of the genes from each parent and can make new combinations of jigs. This determines the individual's unique characteristics. But the genes are not used directly — they are first copied into "blueprints" to be used in the factory itself, outside the nucleus, where the genes are never allowed to go.

The genes are really coded structures made up of four kinds of molecules called "bases," put together into a complex structure called a nucleic acid. A certain length of the kind of nucleic acid found in chromosomes, called DNA, is a single gene, and it carries the specifications for a single protein to be built. The blueprints are copies of this genetic information in a second kind of nucleic acid, RNA, which also carries its message in the arrangements of four sub-units. These sub-unit bases are the chemical molecules called adenine, cytosine, guanine, and uracil, and are referred to by their initials. Remember that their order is a code that specifies the organization of a particular protein with a specific function.

Three are terminators and give a STOP message that cuts off the protein building at that point.

When the blueprint-RNA is shipped out into the cell's factory, it is operated on by a cellular structure that reads the message in a very special manner, much as a film-strip projector shows the film one frame at a time. The frames in this case contain three of the bases at a time, and each set of three bases in a row is called a codon — the smallest piece of information in the RNA message. Recall that there are twenty kinds of amino acids but only four kinds of bases. This means that the smallest quantity of coded information that can translate a code of four symbols into another of twenty symbols must have a minimum of three symbols per unit. (There is an exercise in combinatorics for you.) Each codon of the RNA is thus equivalent to one amino acid (except for three that are terminators and give a STOP message that cuts off the protein building at that point). With four symbols taken three at a time in specific order, there are 64 kinds of codons. Since there are only twenty amino acids, you get a lot of synonyms (called redundancy), but that has its advantages too.

Mutations are changes in the structure of the genes that, by way of the messenger RNA, are translated into incorrectly built proteins. These "bad" proteins usually either do something wrong or do not do whatever they were supposed to do. Either of these can upset the functioning of the cell and the individual. Thus things that cause mutations, like radiation and many kinds of chemicals, are bad for the health also.

You have three options: you can change one base in the message to another, or insert some more bases into the list, or take out some bases.

Enough of that. Let's look at what the program does.

Briefly, CODON invites you to enter a sequence of base initials, A, C, G or U, in any order you desire up to a total of 150 in up to three lines. Short examples do as well as long ones, usually. This message is then echoed back to you in codon-groups, three letters at a time, as shown in Figure 1.

```
RNA MESSAGE NOW READS (BY CODONS):

AUC AUC AUC AUC AUC AUC

YOUR INPUT STRING TRANSLATES TO:

ILE-ILE-ILE-ILE-ILE-ILE-
```

Figure 1. The original input string of RNA bases is echoed in codon groups of three bases and translated into the corresponding amino acid string. Only one codon type is used to make the changes more evident.

Here, a simple sequence repeating the codon AUC was used. The program then translates that RNA message into the corresponding sequence of amino acids it would produce in the cell. In the example, AUC translates into a sequence of the amino acid, isoleucine, abbreviated by the letters ILE. If you look at lines 7160-7250 you will see the abbreviations used, which will be printed for you if you ask for information at the beginning of the program. See the full sample run, too.

You then have three options (other than stopping): you can change one base in the message to another, or insert some more bases into the list, or take out some bases. Figure 2 shows what happens when you change base number 8 from U to C. One amino acid in the structure is changed this time, from ILE to THR, or threonine. This simple mutation, representative of the smallest genetic change possible, can be extremely important. The only difference between the normal hemoglobin that most of us have in our cells and the sickle-cell hemoglobin that can kill its carriers through severe anemia is just such a single amino acid substitution, putting in valine instead of the glutamic acid that is usually present. The RNA message change was probably putting a U where an A belonged.

```
RNA MESSAGE NOW READS (BY CODONS):
         ↓
AUC AUC ACC AUC AUC AUC

PROTEIN HAS NOW BECOME:

ILE-ILE-THR-ILE-ILE-ILE-
```

Figure 2. The base at position 8 (indicated by an arrow) was changed from U to C, and the resulting amino acid string has one different acid because of this mutation.

Figure 3 shows what happens when you add a single base. If you examine the sequence, you will find that a new C has been stuck into the sequence at position 7. The list is now one base longer, but the program does not translate the stray end. Two things will be apparent. First, you can see that the whole protein after the insertion has been changed — to a sequence of histidines (HIS). Secondly, the third and fourth codons, CAC and CAU, both translate into HIS, an example of the code redundancy.

```
RNA MESSAGE NOW READS (BY CODONS):
        ↓
AUC AUC CAC CAU CAU CAU C

CURRENT PROTEIN READS:

ILE-ILE-HIS-HIS-HIS-HIS-
```

Figure 3. A new base, C, was inserted into the string after position 6, with the result that the whole message has changed beyond the position of the insertion. Note also that two different codons have been translated into one amino acid — an example of code redundancy.

If you now take out a base, number 13 in the example, you get the results shown in Figure 4. Here you can see

```
RNA MESSAGE NOW READS (BY CODONS):

AUC AUC CAC CAU AUC AUC
               ↑
PROTEIN NOW HAS THIS STRUCTURE:

ILE-ILE-HIS-HIS-ILE-ILE-
```

Figure 4. The arrow indicates the position (#13 of the previous one) from which a base, C, was removed. This causes the amino acid chain to be different between the two changes made, compared to Figure 1, but the same both before and after them.

that there is a place in the sequence between the insertion and the deletion that is different from the original, but both ends are back to where you started. It was by using techniques like this that Nobel prizewinner Francis Crick demonstrated that codons really were three bases long — adding three or taking out three bases leaves the protein between modified but the ends the same. If the modified length is not too great, the protein may still function partly — depending on a lot of things. In general, however, any mutations cause problems that may vary from insignificant to great.

Each set of three bases in a row is called a codon — the smallest piece of information in the RNA message. There are twenty kinds of amino acids but only four kinds of bases.

Each of the parts of the program is marked by REM lines so that it should be easy to follow. The codon dictionary (found in the data lines 6000 to 6080) is read into array C by lines 150 — 170. It is used to translate the RNA message. If your version of Basic does not accept three-dimensional arrays some rewriting will be needed here. Notice also that I used the DEFSTR (define string) and DEFINT (define integer) functions of the TRS-80 Basic to declare the types of several variables ahead of time. At least the C's, A's and S's in the program would need to be changed to C$'s, etc., if you do not have this capacity. Also permitted here, but perhaps not by your interpreter, is the reading of string data without quotation marks from lines 6000 - 6080.

The program segment in lines 211 to 216 allows you to divert all input and output to the printer if you wish. If you answer "yes" to the first question, the two pairs of PEEK statements pick up the addresses of the video driver (VL% and VH% — low and high bytes) and printer driver (PL% and PH%), and then two POKEs put the printer driver address where the video driver address usually resides. When you stop the run (at lines 510-530, by selecting option 4 from the menu), the video addresses are restored to their proper places. The complete run example was produced by this option. It is best not to stop the program with the <BREAK> key.

The routine at lines 340-390 reads in your input string and puts together a long one, C1. The echo routine at subroutine 8700 puts the input string C1 into string C5 and lists the input string by codons. String C5 has spaces inserted between the groups of three bases, which are not wanted by the translating routines.

Translating is done by the subroutine beginning at 8000, which in turn calls another at 8200. The second translates the letters of each successive codon in your input string into numbers by which to access the array C, and the prime subroutine builds another string, A, which is then printed out by the subroutine at 8500. In both printing subroutines line lengths are controlled so a uniform and neat output is produced. The whole program is written for video display; but, as noted above, output can be sent to the printer if you wish.

The segments that insert or delete strings of bases into the original (or any subsequent) string start at lines 2000 and 3000. All they do is find out what location is desired, break the original string into the two ends needed, and put in or take out what you request. If you ask to delete beyond the end of the string, the end is cut off and the extra "deletion" is ignored. You can't delete more than the whole string, though.

The program is written in Disk Basic, but the only unique feature is used in line 1060 of the change-a-base routine. This is the MID$ function on the left side of an assignment statement. To convert to Level II Basic this line would need to be rewritten to use the techniques of the insert or delete methods. The following substitution for line 1060 will work:

1060 C2=LEFT$(C1,K1-1):
C3=RIGHT$(C1,L-K1):
C1=C2+A5+C3

It was by using techniques like this that Crick demonstrated that codons really were three bases long.

It is the only change that should be needed, however, as everything else is standard usage.

With that amount of description, everything else should be easily followed. Most common mistakes (like entering an incorrect letter) are trapped, and lots of prompts and information are provided to make this an essentially independent program once its basic intentions are understood. □

Figure 5. A full run of the program using the printer option, including the information that is optionally provided.

```
DO YOU WANT INFORMATION AND INSTRUCTIONS? Y

MESSENGER RNA IS A COPY OF THE GENETIC INFORMATION IN
THEN DNA OF THE GENE IN THE CHROMOSOME. THE ORDER OF THE
FOUR BASES (A = ADENINE, C = CYTOSINE, G = GUANINE, AND
U = URACIL) DETERMINES THE ORDER OF THE AMINO ACIDS IN
THE PROTEIN.  THAT ORDER REGULATES THE FUNCTION OF THE
PROTEIN IN THE CELL.

YOU MAY ENTER A STRING OF BASES TO SIMULATE THE
STRUCTURE OF THE RNA MOLECULE.  USE ONLY THE LETTERS,
A, C, G, AND U, AND LEAVE NO SPACES. IF YOU WANT MORE
THAN ABOUT 50, USE 2 OR 3 LINES BUT DO NOT ENTER MORE
THAN 150 BASES IN ALL.

    DO YOU WANT MORE INFORMATION? Y

EACH GROUP OF THREE BASES IN THE MESSAGE IS CALLED A CODON.
EACH CODON TRANSLATES INTO ONE AMINO ACID IN THE PROTEIN.
THE AMINO ACID ABBREVIATIONS ARE:
ALA = ALANINE             LEU = LEUCINE
ARG = ARGENINE            LYS = LYSINE
ASN = ASPARAGINE          MET = METHIONINE
ASP = ASPARTIC ACID       PHE = PHENYLALANINE
CYS = CYSTEINE            PRO = PROLINE
GLN = GLUTAMINE           SER = SERINE
GLU = GLUTAMIC ACID       THR = THREONINE
GLY = GLYCINE             TRP = TRYPTOPHANE
HIS = HISTIDINE           TYR = TYROSINE
ILE = ISOLEUCINE          VAL = VALINE
    READY? Y

YOU MAY NOW ENTER AN RNA MESSAGE.
ENTER NO MORE THAN THREE LINES OF DATA NOR MORE THAN 150
BASES IN ALL, USING ONLY LETTERS A, C, G, AND U
RESPOND TO '?' WITH <ENTER> IF DONE WITH INPUT.
? ACCGUGCACUAGGUCAAUCG
?
LENGTH IS 20

RNA MESSAGE NOW READS (BY CODONS):

ACC GUG CAC UAG GUC AAU CG

YOUR INPUT STRING TRANSLATES TO:

THR-VAL-HIS-STOP

YOU CAN MAKE ANY OF THESE CHANGES:
   1.   CHANGE ONE BASE IN THE LIST.
   2.   INSERT ONE OR MORE ADJACENT BASES.
   3.   DELETE ONE OR MORE ADJACENT BASES.
  OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 1

CHANGE A SINGLE BASE IN RNA MESSAGE


CHANGE WHICH BASE (NUMBER)? 10
BASE NUMBER 10 IS NOW U
WHAT BASE DO YOU WISH TO CHANGE IT TO? C

RNA MESSAGE NOW READS (BY CODONS):

ACC GUG CAC CAG GUC AAU CG

PROTEIN HAS NOW BECOME:

THR-VAL-HIS-GLN-VAL-ASN-

YOU CAN MAKE ANY OF THESE CHANGES:
   1.   CHANGE ONE BASE IN THE LIST.
   2.   INSERT ONE OR MORE ADJACENT BASES.
   3.   DELETE ONE OR MORE ADJACENT BASES.
  OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 2

INSERT BASES INTO RNA MESSAGE

ENTER STRING OF BASES TO INSERT:
? CCAAGGUUCAC
INSERT AFTER WHICH BASE (NUMBER)? 18
RNA NOW HAS 31  BASES

RNA MESSAGE NOW READS (BY CODONS):

ACC GUG CAC CAG GUC AAU CCA AGG UUC ACC G

CURRENT PROTEIN READS:

THR-VAL-HIS-GLN-VAL-ASN-PRO-ARG-PHE-THR-

YOU CAN MAKE ANY OF THESE CHANGES:
   1.   CHANGE ONE BASE IN THE LIST.
   2.   INSERT ONE OR MORE ADJACENT BASES.
   3.   DELETE ONE OR MORE ADJACENT BASES.
  OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 3

DELETE BASES FROM RNA MESSAGE

HOW MANY BASES DO YOU WISH TO REMOVE? 4

DELETE BEGINNING WITH WHICH BASE (NUMBER)? 5
RNA NOW HAS 27  BASES

RNA MESSAGE NOW READS (BY CODONS):

ACC GCC AGG UCA AUC CAA GGU UCA CCG

PROTEIN NOW HAS THIS STRUCTURE:

THR-ALA-ARG-SER-ILE-GLN-GLY-SER-PRO-

YOU CAN MAKE ANY OF THESE CHANGES:
   1.   CHANGE ONE BASE IN THE LIST.
   2.   INSERT ONE OR MORE ADJACENT BASES.
   3.   DELETE ONE OR MORE ADJACENT BASES.
  OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 4
```

Genetic, cont'd...

Program Listing

```
10 REM     CODON PROGRAM
20 REM     (C) DICK STRAW 1980
30 REM     TRS-80 DISK BASIC
40 REM
100 CLEAR 2000
110 DEFSTR C,A,S: DEFINT I-N
120 DIM C(4,4,4)
150 FOR I=1 TO 4:FOR J=1 TO 4: FOR K=1 TO 4
160 READ C(I,J,K)
170 NEXT K,J,I
200 CLS:PRINTTAB(20);"CODON PROGRAM"
210 PRINT:PRINT"SIMULATES TRANSLATION OF MESSENGER-RNA INTO PROTEIN"
211 PR%=0: INPUT"DO YOU WANT OUTPUT TO PRINTER";S1
212 IF ASC(S1) <> 89 GOTO 220
213 PR%=1: INPUT"WHEN PRINTER IS READY, PRESS ENTER";S1
214 PL%= PEEK(16422): PH%= PEEK(16423)
215 VL%= PEEK(16414): VH%= PEEK(16415)
216 POKE 16414,PL%: POKE 16415,PH%
220 PRINT:INPUT"DO YOU WANT INFORMATION AND INSTRUCTIONS";S1
230 IF ASC(S1)=89 THEN GOSUB 7000
299 REM    START MAIN PROGRAM
300 PRINT:PRINT"YOU MAY NOW ENTER AN RNA MESSAGE."
310 PRINT"ENTER NO MORE THAN THREE LINES OF DATA NOR MORE THAN 150"
320 PRINT"BASES IN ALL, USING ONLY LETTERS A, C, G, AND U"
330 PRINT"RESPOND TO '?' WITH <ENTER> IF DONE WITH INPUT."
340 C1=""
350 FOR I=1 TO 3
360 C2="": INPUT C2
370 IF C2="" GOTO 400
380 C1=C1+C2
390 NEXT I
400 L=LEN(C1): PRINT"LENGTH IS";L
405 GOSUB 8700
410 PRINT:PRINT"YOUR INPUT STRING TRANSLATES TO:"
420 GOSUB 8000         'TRANSLATING ROUTINE
430 GOSUB 8500         'PRINT PROTEIN
440 PRINT:PRINT"YOU CAN MAKE ANY OF THESE CHANGES:"
450 PRINT"   1.   CHANGE ONE BASE IN THE LIST."
460 PRINT"   2.   INSERT ONE OR MORE ADJACENT BASES."
470 PRINT"   3.   DELETE ONE OR MORE ADJACENT BASES."
480 PRINT"  OR STOP (TYPE 4)"
490 INPUT"WHICH DO YOU CHOOSE";N
500 ON N GOTO 1000, 2000, 3000, 510
510 IF PR%=0 GOTO 530
520 POKE 16414,VL%: POKE 16415,VH%
530 STOP
999 REM  CHANGE ONE BASE
1000 PRINT:PRINT"CHANGE A SINGLE BASE IN RNA MESSAGE"
1010 PRINT:INPUT"CHANGE WHICH BASE (NUMBER)";K1
1020 IF K1>L OR K1<0 PRINT"INVALID NUMBER":GOTO 1010
1030 A5= MID$(C1,K1,1)
1040 PRINT"BASE NUMBER";K1;"IS NOW ";A5
1050 INPUT"WHAT BASE DO YOU WISH TO CHANGE IT TO";A5
1060 MID$(C1,K1,1) = A5
1070 GOSUB 8700             'PRINT RNA
1080 PRINT:PRINT"PROTEIN HAS NOW BECOME:"
1090 GOSUB 8000
1100 GOSUB 8500
1110 GOTO 440
1999 REM  INSERT BASES
2000 PRINT:PRINT"INSERT BASES INTO RNA MESSAGE"
2010 PRINT: A5="": PRINT"ENTER STRING OF BASES TO INSERT:"
2020 INPUT A5
2060 L2=LEN(A5): IF L2+L > 150 PRINT"TOO LONG":GOTO 2010
2070 INPUT"INSERT AFTER WHICH BASE (NUMBER)";K1
2080 IF K1>L PRINT"NOT A VALID LOCATION - PAST END":GOTO 2070
2090 C2=LEFT$(C1,K1): L2=L-K1
2100 C3=RIGHT$(C1,L2)
2120 C1=C2+A5+C3: L=LEN(C1)
2130 PRINT"RNA NOW HAS";L;" BASES"
2140 GOSUB 8700
2150 PRINT:PRINT"CURRENT PROTEIN READS:"
2160 GOSUB 8000
2170 GOSUB 8500
2180 GOTO 440
2999 REM   REMOVE BASES
3000 PRINT:PRINT"DELETE BASES FROM RNA MESSAGE"
3010 PRINT:INPUT"HOW MANY BASES DO YOU WISH TO REMOVE";L2
3020 IF L-L2 < 0 PRINT"RNA IS NOT THAT LONG":GOTO 3010
3030 PRINT:INPUT"DELETE BEGINNING WITH WHICH BASE (NUMBER)";K1
3040 L3=L-K1-L2: IF L3<0 THEN L2=L-K1: GOTO 3040
3050 C2=LEFT$(C1,K1-1): C3=RIGHT$(C1,L3+1)
3060 C1=C2+C3: L=LEN(C1)
3070 PRINT"RNA NOW HAS";L;" BASES"
3080 GOSUB 8700
3090 PRINT:PRINT"PROTEIN NOW HAS THIS STRUCTURE:"
3100 GOSUB 8000
3110 GOSUB 8500
3120 GOTO 440
4000 END
4001 REM


6000 REM   CODON DICTIONARY
6010 DATA PHE-,PHE-,LEU-,LEU-,SER-,SER-,SER-,SER-
6020 DATA TYR-,TYR-,STOP,STOP,CYS-,CYS-,STOP,TRP-
6030 DATA LEU-,LEU-,LEU-,LEU-,PRO-,PRO-,PRO-,PRO-
6040 DATA HIS-,HIS-,GLN-,GLN-,ARG-,ARG-,ARG-,ARG-
6050 DATA ILE-,ILE-,ILE-,MET-,THR-,THR-,THR-,THR-
6060 DATA ASN-,ASN-,LYS-,LYS-,SER-,SER-,ARG-,ARG-
6070 DATA VAL-,VAL-,VAL-,VAL-,ALA-,ALA-,ALA-,ALA-
6080 DATA ASP-,ASP-,GLU-,GLU-,GLY-,GLY-,GLY-,GLY-
6999 REM
7000 REM  INFORMATION TEXT
7010 PRINT:PRINT"MESSENGER RNA IS A COPY OF THE GENETIC INFORMATION IN"
7020 PRINT"THEN DNA OF THE GENE IN THE CHROMOSOME. THE ORDER OF THE"
7030 PRINT"FOUR BASES (A = ADENINE, C = CYTOSINE, G = GUANINE, AND"
7040 PRINT"U = URACIL) DETERMINES THE ORDER OF THE AMINO ACIDS IN"
7050 PRINT"THE PROTEIN.  THAT ORDER REGULATES THE FUNCTION OF THE"
7060 PRINT"PROTEIN IN THE CELL."
7070 PRINT:PRINT"YOU MAY ENTER A STRING OF BASES TO SIMULATE THE"
7080 PRINT"STRUCTURE OF THE RNA MOLECULE.  USE ONLY THE LETTERS,"
7090 PRINT"A, C, G, AND U, AND LEAVE NO SPACES. IF YOU WANT MORE"
7100 PRINT"THAN ABOUT 50, USE 2 OR 3 LINES BUT DO NOT ENTER MORE"
7110 PRINT"THAN 150 BASES IN ALL."
7120 PRINT:INPUT"    DO YOU WANT MORE INFORMATION";S1
7130 IF ASC(S1) <> 89 THEN RETURN
7140 PRINT:PRINT"EACH GROUP OF THREE BASES IN THE MESSAGE IS CALLED A CODON."
7150 PRINT"EACH CODON TRANSLATES INTO ONE AMINO ACID IN THE PROTEIN."
7155 PRINT"THE AMINO ACID ABBREVIATIONS ARE:"
7160 PRINT"ALA = ALANINE           LEU = LEUCINE"
7170 PRINT"ARG = ARGENINE          LYS = LYSINE"
7180 PRINT"ASN = ASPARAGINE        MET = METHIONINE"
7190 PRINT"ASP = ASPARTIC ACID     PHE = PHENYLALANINE"
7200 PRINT"CYS = CYSTEINE          PRO = PROLINE"
7210 PRINT"GLN = GLUTAMINE         SER = SERINE"
7220 PRINT"GLU = GLUTAMIC ACID     THR = THREONINE"
7230 PRINT"GLY = GLYCINE           TRP = TRYPTOPHANE"
7240 PRINT"HIS = HISTIDINE         TYR = TYROSINE"
7250 PRINT"ILE = ISOLEUCINE        VAL = VALINE"
7260 INPUT"    READY";S1
7270 RETURN
7999 REM
8000 REM  TRANSLATING ROUTINE
8010 A="": FOR I=1 TO L STEP 3
8020 C3="": C3= MID$(C1,I,3)
8025 IF LEN(C3) < 3 GOTO 8130
8030 A2 = LEFT$(C3,1): GOSUB 8200
8040 J1=J: IF J=0 GOTO 8120
8050 A2 = MID$(C3,2,1): GOSUB 8200
8060 J2=J: IF J=0 GOTO 8120
8070 A2 = RIGHT$(C3,1): GOSUB 8200
8080 J3=J: IF J=0 GOTO 8120
8090 A1= C(J1,J2,J3): A=A+A1: IF A1="STOP" GOTO 8130
8100 NEXT I
8120 IF J=0 PRINT"BAD BASE IN CODON AT POSITION";I;" - ";C3
8130 RETURN
8200 REM DECODING BASES TO DICTIONARY INDICES
8205 J=0
8210 IF A2="U" THEN J=1: GOTO 8250
8220 IF A2="C" THEN J=2: GOTO 8250
8230 IF A2="A" THEN J=3: GOTO 8250
8240 IF A2="G" THEN J=4
8250 RETURN
8500 REM    PRINT PROTEIN
8510 IF LEN(A) < 57 PRINT :PRINT A: RETURN
8520 A1 = LEFT$(A,56)
8530 A2 = MID$(A,57,56): A3="": A4=""
8540 IF LEN(A) > 112 THEN A3=MID$(A,113,56)
8550 IF LEN(A) > 168 THEN A4=MID$(A,169,56)
8560 PRINT:PRINT A1: PRINT: PRINT A2
8570 IF LEN(A3) > 0 THEN PRINT: PRINT A3
8580 IF LEN(A4) > 0 THEN PRINT: PRINT A4
8590 RETURN
8700 REM    PRINT RNA MESSAGE
8705 PRINT:PRINT"RNA MESSAGE NOW READS (BY CODONS):"
8710 C5="": FOR I=1 TO LEN(C1) STEP 3
8720 C5=C5+MID$(C1,I,3)+" "
8725 NEXT I
8730 IF LEN(C5)<57 PRINT: PRINT C5: RETURN
8740 C2=LEFT$(C5,56): C3=MID$(C5,57,56): C7="":C8=""
8750 IF LEN(C5) > 112 THEN C7=MID$(C5,113,56)
8760 IF LEN(C5) > 168 THEN C8=MID$(C5,169,56)
8770 PRINT:PRINT C2: PRINT: PRINT C3
8780 IF LEN(C7)>0 THEN PRINT:PRINT C7
8790 IF LEN(C8)>0 THEN PRINT:PRINT C8
8800 RETURN
```

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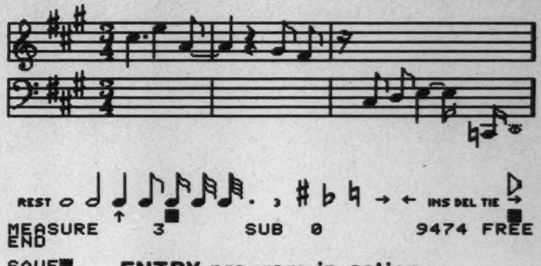

```
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END
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```

ENTRY program in action

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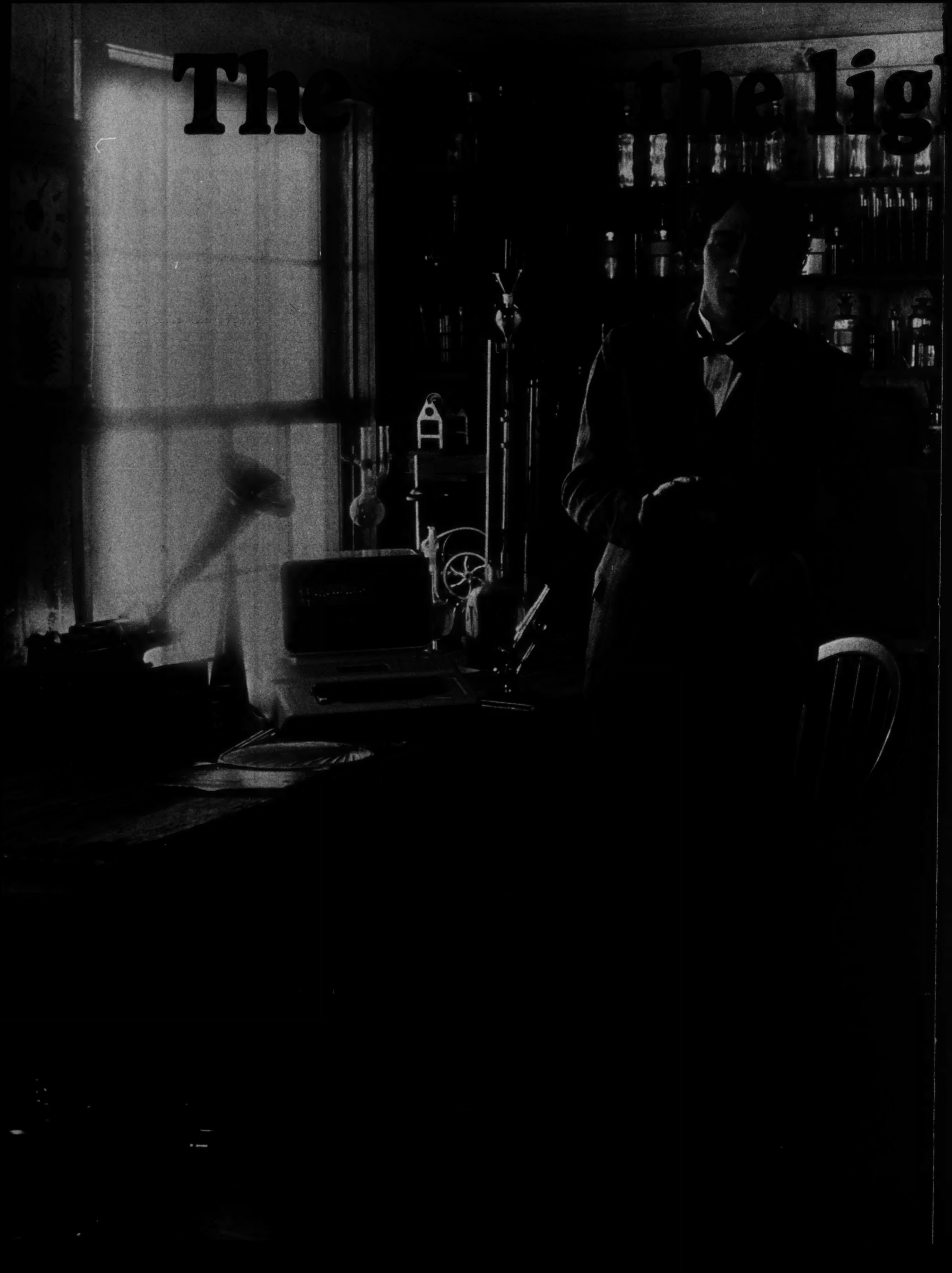
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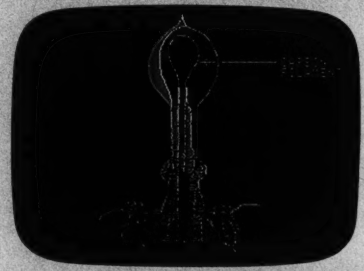

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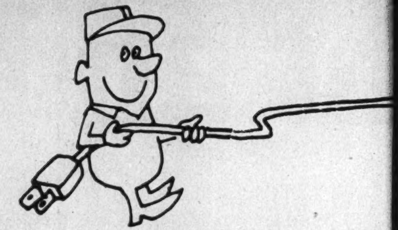

Ralph White

Game Description

THE ELECTRIC COMPANY is an economic game/simulation. The user is made president of the company for ten years — unless mismanagement forces earlier retirement.

At the beginning of year one, the company has one million dollars, 1600 tons of coal, 2500 barrels of fuel oil, one power plant and 700 customers. All power plants have a capacity of one million kilowatts. The user may choose which type of fuel to use at each power plant he owns — the one he starts with as well as each one that is built. Coal plants are more expensive to build than fuel oil power plants, but they are cheaper to operate.

If more than one power plant is owned, the amount of power generated can be divided between or among the plants in any fashion desired — as long as no plant generates more than one million kilowatts. The only requirement is that enough power be generated to meet demand. Demand is determined by the number of customers. In a normal year in the program each customer consumes one thousand kilowatts.

The kilowatt demand is displayed for the user. If more than one plant is being operated, the display will subtract the power you chose to generate from previous plants and displays only the remaining kilowatts needed to meet demand.

If the amount of power generated falls short of the customers' demand then a brown-out occurs. This does not terminate the game, but damage is done to the generators and the company is charged an amount of money for repairs. The more the generated amount of electricity is below the demand, the more it will cost to repair the damage.

If the kilowatt demand outstrips the generating capacity of the company, then the generators go "poof!" and the game is terminated.

As power plants get older, they become increasingly inefficient. Each year the president of the company has to decide whether or not to remodel the plant(s). To aid in making the decision, a print out of cost for each plant, the percent of increase in efficiency for each plant, and total cost is shown. If the decision is to remodel, all plants are remodeled at the same time. The longer one waits to remodel, the more it will cost. The cost of remodeling is in part based on the increase of efficiency. Remodeling does not increase each plant's capacity. It makes each plant more efficient; it will use less fuel to make a kilowatt of electricity.

Very little in the program is allowed to remain constant. The population does not remain stable throughout the game. Each year, there is growth in the number of customers. Usually, the number of customers will increase at a rate that will require the building of a second power plant before the ten year term is completed.

Not only is the population not stable, but neither is the economy. An inflationary spiral is built into the price of all goods and services except one — the rate the company charges per kilowatt of electricity. As the program advances through each year, fuel, power plants, damage charges, etc. become more expensive.

Although the price per kilowatt the company gets for electricity does not automatically increase with inflation, a provision is made for applying for a rate increase each year. Rate increases are not allowed in two consecutive years. By waiting two years a rate increase request will be accepted if it is not too large. If it exceeds the upper limit defined by the program (which is tied to the Consumer Price Index), the request will be denied. If three or more years elapse between rate increases not only will the increase be accepted if it falls within the program's guide lines, but if it is too large, the program will yield a lesser compromise rate increase. Since an increase is not allowed every year, the upper limit for an allowable increase exceeds the Consumer Price Index.

Each year there is a 50 percent chance of some unforeseen event. These are not always bad or disastrous. Demand may rise a little faster or slower than usual, the company may be charged to repair storm damage to equipment, customers may be lost, additional customers may want to be hooked into the system (it costs the company a one-time fee to add these customers so the option of refusing service to them is given). If there are any costs involved in any of the above events, they will be influenced by inflation also.

Not all decisions become effective immediately. When ordering coal and fuel oil there is a lead time of one year. The fuel does not become available for use until the following year. Enough fuel must be on hand to supply the current year's needs. The same lead time of one year applies to rate increases also.

Two reports are shown. The first report, at the beginning of each year, shows the cash reserve, coal and fuel oil amounts, number of customers and number of plants owned. The second report, at the end of each year, displays the gross income, the maintenance costs for the year (maintenance costs are influenced by number of plants being operated, number of customers being served and the Consumer Price Index), percent of generating capacity that is being used, the inflation rate for the past year and the consumer price index.

Program Notes

THE ELECTRIC COMPANY is written in Radio Shack Level II Basic and requires 11K of memory. The instructions and scenario (not shown in the sample run) are located in lines 90-500.

The left hand brackets in lines 1820 and 1830 are the line printer's representation of an exponential arrow. If the Basic you have access to does not support exponentiation, substitute R*PI*SQR(PI). This yields the same result.

The "#" after some of the variables such as CR# indicates double precision. This prevents the output from appearing in scientific notation if the value of the variable exceeds six digits.

The strings defined in lines 10 and 20 are used in conjunction with the PRINTUSING statements to format the print-out of data by inserting dollar signs, commas and decimal points, or restricting numbers to two decimal places. If the PRINTUSING command is not available to you, the lines may be rewritten with only PRINT statements.

For those of you who wish to modify the degree of difficulty of the program, line 540 defines the initial values of the variables that are to be managed. □

Ralph G. White, 529 South Vermont, Columbus, KS 66725

```
10 D$="$$###,###,###.##":X$="   ###,###,###":C$="$$##.##"
20 E$="$$###,###.##"
30 CLS:PRINTCHR$(23):PRINT:PRINT:PRINT
40 A$="+--++--++--++--++--++--++--+"
50 PRINTA$:PRINT:PRINT"        ELECTRIC COMPANY":PRINT:PRINT:PRINTA$
60 FORJ=1TO1200:NEXT
70 CLS:INPUT"DO YOU NEED INSTRUCTIONS (YES/NO) ";Z$
80 IFZ$="NO"GOTO540
90 CLS:PRINT"YOU HAVE BEEN HIRED AS PRESIDENT OF AN ELECTRIC COMPANY."
100 PRINT"YOU WILL BE PRESIDENT FOR 10 YEARS BEFORE BEING NAMED TO THE"
110 PRINT"BOARD OF DIRECTORS--ASSUMING A SUCCESSFUL TERM AS PRESIDENT."
120 PRINT"     YOU WILL START WITH ONE MILLION DOLLARS IN CASH, 1 POWER"
130 PRINT"PLANT AND STOCK PILES OF COAL AND FUEL OIL--THE TWO FUELS YOU"
140 PRINT"MAY USE TO POWER A GENERATING PLANT.  YOU MAY CHOOSE EITHER"
150 PRINT"FUEL YOU WISH TO POWER THE PLANT YOU START WITH AND EACH"
160 PRINT"SUCCEEDING PLANT YOU BUILD THEREAFTER.  ALL PLANTS HAVE A"
170 PRINT"GENERATING CAPACITY OF 1 MILLION KILOWATTS.  AS THE PLANTS"
180 PRINT"BECOME OLDER, THEY BECOME INCREASINGLY INEFFICIENT.  THAT IS,"
190 PRINT"THEY REQUIRE MORE FUEL TO PRODUCE EACH KILOWATT OF ELECTRICITY."
200 PRINT"THEY CAN BE BROUGHT BACK TO PEAK EFFICIENCY BY REMODELING THEM."
210 PRINT"THE LONGER YOU WAIT TO REMODEL, THE MORE IT WILL COST.  AND IF"
220 PRINT"MORE THAN ONE PLANT IS OWNED, ALL PLANTS MUST BE REMODELED AT"
230 PRINT"THE SAME TIME."
240 INPUT"PRESS 'ENTER' TO CONTINUE INSTRUCTIONS ";Z$
250 CLS:PRINT"YOU HAVE TWO FUELS FROM WHICH TO CHOOSE: COAL AND FUEL OIL."
260 PRINT"COAL TENDS TO YIELD MORE KILOWATTS PER DOLLAR OF FUEL; HOWEVER,"
270 PRINT"COAL PLANTS COST ABOUT 50% MORE TO BUILD THAN FUEL OIL PLANTS."
280 PRINT"     MANAGEMENT OF FUEL SUPPLIES IS IMPORTANT BECAUSE THERE IS"
290 PRINT"A LEAD TIME OF 1 YEAR BEFORE IT ARRIVES.  COAL ORDERED IN YEAR"
300 PRINT"4 IS NOT AVAILABLE FOR USE UNTIL YEAR 5, SO A CLOSE EYE MUST BE"
310 PRINT"KEPT ON FUEL RESERVES."
320 PRINT"     INFLATION AFFECTS THE COST OF ALMOST EVERYTHING YOU"
330 PRINT"ENCOUNTER, FROM FUEL COSTS TO DAMAGE CAUSED BY DISASTER OR"
340 PRINT"JUDGEMENT ERROR.  IF YOU FIND THAT A RATE INCREASE IS REQUIRED"
350 PRINT"TO MAINTAIN A PROFITABLE BUSINESS AND KEEP THE STOCK HOLDERS"
360 PRINT"HAPPY, YOU MAY APPLY FOR A RATE INCREASE EACH YEAR.  ALL YOU DO"
370 PRINT"IS SPECIFY WHAT YOU WANT THE NEW RATE TO BE (THE INITIAL RATE"
380 PRINT"IS .05 PER KILOWATT)."
390 PRINT:INPUT"PRESS 'ENTER' TO CONTINUE INSTRUCTIONS ";Z$
400 CLS:PRINT"     TEMPER YOUR RATE REQUESTS WITH MODERATION.  GREED WILL"
410 PRINT"GET YOU NOWHERE.  RATE INCREASES CAN BE REJECTED AS WELL AS"
420 PRINT"ACCEPTED.  BY WAITING LONGER BETWEEN INCREASE REQUESTS, YOU"
430 PRINT"CAN ASK FOR A LARGER INCREASE AND HAVE IT ACCEPTED.  ALSO BY"
440 PRINT"WAITING LONGER BETWEEN REQUESTS, A COMPROMISE RATE INCREAS MAY"
450 PRINT"BE GRANTED--WHERE AS FREQUENT REQUESTS MAY RESULT IN A DENIED"
460 PRINT"INCREASE.  AS WITH FUEL ORDERS, THERE IS A LEAD TIME OF 1 YEAR"
470 PRINT"FOR RATE HIKES.  A RATE INCREASE GRANTED IN YEAR 6 DOES NOT"
480 PRINT"TAKE AFFECT UNTIL YEAR 7."
490 PRINT:PRINT"     NOW LIKE ALL GOOD EXECUTIVES, YOU MUST GET TO WORK."
500 PRINT"                G O O D   L U C K ! ! !"
510 DEFDBLB-D,K-L
520 DEFDBLB-D,K-L
530 PRINT:PRINT:INPUT"PRESS 'ENTER' TO BEGIN ";Z$
540 YR=0:PI=1:GF=1:CS=700:CC=20:CF=25:CL=1600:FO=2500:CR#=1000000:R=.05:RT=
550 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
560 INPUT"1=COAL   2=FUEL OIL";F(1)
570 IFF(1)<1ORF(1)>2GOTO550
580 EF(1)=1
590 YR=YR+1
600 I=0
610 E=(100+RND(10))/100
620 I=I+1:EF(I)=EF(I)*E:IFI<GFGOTO610
630 CLS:PRINT"   ***** FINANCES FOR BEGINNING OF YEAR ";YR;" *****":PRINT
640 PRINT"GENERATING PLANTS OWNED              ";:PRINTUSINGX$;GF
650 PRINT"NUMBER OF CUSTOMERS                  ";:PRINTUSINGX$;CS
660 PRINT"TONS OF COAL IN STOCK                ";:PRINTUSINGX$;CL
670 PRINT"BARRELS OF FUEL OIL IN STOCK         ";:PRINTUSINGX$;FO
680 PRINT"CASH RESERVE                         ";:PRINTUSINGD$;CR#
690 PRINT:INPUT"PRESS 'ENTER' TO BEGIN THE YEAR'S TRANSACTIONS";Z$
700 IFCR#>0GOTO780
710 CLS:PRINT"YOU HAVE BUNGLED THE JOB.  THE COMPANY IS BROKE."
720 PRINT"YOU HAVE BEEN SENT TO A SIBERIAN SALT MINE TO COOL YOUR HEELS."
730 PRINT:GOTO2220
740 PRINT"YOU HAVE MISMANAGED YOUR FUEL INVENTORY.  THAT IS TOO BAD, FOR"
750 PRINT"YOU WERE DOING FINE IN OTHER AREAS OF MANAGEMENT.  BUT THE"
760 PRINT"BOARD OF DIRECTORS WERE UNSYMPATHETIC, YOU WERE CANNED."
770 PRINT:GOTO2220
780 IN=(100+RND(12))/100:PI=PI*IN:PG=(100+RND(12))/100
790 MN=((GF*5000)+(CS*10))*PI:CR#=CR#-MN
800 CS=INT(CS*PG):KD#=CS*1000:GC=1000000*GF
810 CC=INT(2000*PI)/100:SC=INT(100*PI*(RND(30)+20)/10)/100
820 OC=INT(2500*PI)/100:SO=INT(100*PI*(RND(10)+10)/10)/100
830 EV=RND(10):IFEV>5GOTO1000
840 ONEVGOTO850 ,920 ,940 ,960 ,980
850 CA=RND(100):HU=INT((500+RND(500)+(1/CA)*RND(500))*PI)
860 CLS:PRINTCA;" PEOPLE HAVE REQUESTED TO BE ADDED TO THE CUSTOMER LIST."
870 PRINT"IT WILL COST $";HU;" TO HOOK THE CUSTOMERS TO YOUR SYSTEM."
880 PRINT"DO YOU WISH TO SELL POWER TO THEM?":INPUT"1=YES   2=NO";DC
890 IFDC<1ORDC>2GOTO860
900 IFDC=2GOTO1000
910 CS=CS+CA:GOTO1000
920 CA=RND(100):CLS:PRINTCA;" PEOPLE HAVE DROPPED AS CUSTOMERS"
930 CS=CS-CA:GOTO990
940 SD=(RND(1000)+1000)*PI:PRINT"A STORM CAUSED $";SD;" DAMAGE."
950 CR#=CR#-SD:GOTO990
960 PRINT"PEOPLE PROMISE TO CONSERVE.  DEMAND WILL NOT RISE AS SHARPLY"
970 PRINT"THIS YEAR.":KD#=INT(KD#*.9):GOTO990
980 PRINT"DEMAND WILL RISE FASTER THAN USUAL ":KD#=INT(KD#*1.1)
990 FORJ=1TO2000:NEXT
1000 KG=0:NC=0:NF=0:I=0
1010 I=I+1
1020 CLS:PRINTUSINGX$;(KD#-KG);
1030 PRINT" KILOWATTS ARE NEEDED.  YOU HAVE ";GF;" PLANTS."
1040 PRINT"HOW MANY KILOWATTS FROM PLANT ";I;:INPUT" ";K
1050 IFK<=1000000GOTO1070
1060 PRINT"ONE PLANT CAN NOT PRODUCE THAT MUCH.":GOTO1040
1070 KG=KG+K
1080 IFF(I)=2GOTO1120
1090 F=INT((K/600*EF(I))+.5):NC=NC+F:IFNC<CLGOTO1110
1100 NC=NC-F:KG=KG-K:PRINT"YOU DO NOT HAVE ENOUGH COAL.":GOTO740
1110 PRINT"PLANT ";I;" NEEDS ";F;" TONS OF COAL.":GOTO1150
1120 F=INT((K/400*EF(I))+.5):NF=NF+F:IFNF<FOGOTO1140
1130 NF=NF-F:KG=KG-K:PRINT"YOU DID NOT HAVE ENOUGH FUEL OIL.":GOTO740
1140 PRINT"PLANT ";I;" NEEDS ";F;" BARRELS OF OIL."
1150 FORJ=1TO1500:NEXT
1160 IFI<GFGOTO1010
1170 IFKD#>GCGOTO1200
1180 IFKD#>KGGOTO1240
1190 GOTO1280
1200 CLS:PRINT"ALL GENERATORS WERE OVERLOADED!  DEMAND WAS GREATER THAN"
1210 PRINT"CAPACITY.  A MAJOR BLACKOUT OCCURRED.  SEVERE DAMAGE HAS BEEN"
1220 PRINT"CAUSED TO THE GENERATORS AND YOUR CAREER.  YOU HAVE BEEN SENT"
1230 PRINT"TO ANTARCTICA TO MANAGE AN ICE CREAM PARLOR.":GOTO2220
1240 DM=(RND(1000)+2000)*PI*KD#/KG:CR=CR-DM
1250 CLS:PRINT"YOU DID NOT GENERATE ENOUGH TO MEET DEMANDS."
1260 PRINT"$";DM;" DOLLARS WORTH OF DAMAGE HAS BEEN CAUSED TO THE"
1270 PRINT"EQUIPMENT.  FORTUNATELY THIS WAS NOT A FATAL MISTAKE."
1280 PRINT"FUEL REQUIREMENTS"
1290 PRINTNC;" TONS OF COAL":PRINTNF;" BARRELS OF FUEL OIL":PRINT
1300 PRINT"COST PER TON OR BARREL";TAB(30);"SHIPPING";TAB(45);"TOTAL COST"
1310 PC=CC+SC:PO=OC+SO
1320 PRINT"COAL";TAB(10);:PRINTUSINGC$;CC;
1330 PRINTTAB(30);:PRINTUSINGC$;SC;
1340 PRINTTAB(50);:PRINTUSINGC$;PC
1350 PRINT"FUEL OIL";TAB(10);:PRINTUSINGC$;OC;
1360 PRINTTAB(30);:PRINTUSINGC$;SO;
1370 PRINTTAB(50);:PRINTUSINGC$;PO
1380 INPUT"HOW MANY TONS OF COAL DO YOU WISH TO BUY ";CP
1390 INPUT"HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY ";OP
1400 CB=CP*PC:OB=OP*PO
1410 CLS:PRINT"FUEL COSTS";TAB(20);"COAL";TAB(35);"FUEL OIL";TAB(50);"TOTA
1420 PRINTTAB(15);:PRINTUSINGE$;CB;:PRINTTAB(30);:PRINTUSINGE$;OB;
     :PRINTTAB(45);:PRINTUSINGE$;(CB+OB)
1430 ER#=KG*RT:CR#=CR#-CB-OB+ER#:CL=CL+CP-NC:FO=FO+OP-NF
1440 FORJ=1TO2000:NEXT
1450 CLS:PRINT"REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A"
1460 PRINT"PLANT.  IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY.  ALL"
1470 PRINT"PLANTS MUST BE DONE AT THE SAME TIME.":PRINT
1480 PRINT"PLANT";TAB(20);"COST";TAB(40);"INCREASE IN EFFICIENCY"
1490 RM=0
1500 FORI=1TOGF
1510 RC=5000*EF(I)*PI:SV=((EF(I)-1)/EF(I))*100
1520 RM=RM+RC
1530 PRINTI;TAB(15);:PRINTUSINGE$;RC;:PRINTTAB(50);SV;" %"
1540 NEXT
1550 PRINT"TOTAL COST     ";:PRINTUSINGE$;RM
1560 PRINT:PRINT"DO YOU WISH TO REMODEL?":INPUT"1=YES   2=NO";DC
1570 IFDC<1ORDC>2GOTO1560
1580 IFDC=2GOTO1610
1590 CR#=CR#-RM
1600 FORI=1TOGF:EF(I)=1:NEXT
1610 CM=(RND(5000)+45000)*PI:OM=(RND(3000)+30000)*PI
1620 CLS:PRINT"A COAL GENERATING PLANT WILL COST      ";:PRINTUSINGD$;CM
1630 PRINT"A FUEL OIL GENERATING PLANT WILL COST ";:PRINTUSINGD$;OM
1640 PRINT:PRINT"DO YOU WISH TO BUILD A NEW PLANT?"
1650 PRINT"1=COAL   2=FUEL OIL   3=NEITHER"
1660 INPUT"WHAT IS YOUR DECISION ";DC
1670 IFDC<1ORDC>3GOTO1640
1680 IFDC>1GOTO1700
1690 CR#=CR#-CM:GF=GF+1:F(GF)=1:EF(GF)=1:GOTO1720
1700 IFDC>2GOTO1720
1710 CR#=CR#-OM:GF=GF+1:F(GF)=2:EF(GF)=1
1720 CLS:PRINT"DO YOU WISH TO APPLY FOR A RATE INCREASE?"
1730 INPUT"1=YES, 2=NO ";DC
1740 IFDC<1ORDC>2GOTO1720
1750 IFDC=1GOTO1770
1760 GOTO1920
1770 PRINT:PRINT"IT HAS BEEN ";TR;" YEARS SINCE YOU HAD A RAISE."
1780 PRINT"CUSTOMERS ARE PRESENTLY PAYING ";RT;"  PER KILOWATT."
1790 PRINT"HOW MUCH DO YOU WISH TO CHARGE PER KILOWATT?"
1800 INPUT"ENTER REQUEST AS A DECIMAL (.07 OR .075 ETC.)";PR
1810 IFTR<2GOTO1890
1820 IFPR>R*PI[1.5ANDTR<3GOTO1890
1830 IFPR<R*PI[1.5GOTO1870
1840 RT=RT+((PR-RT)*.8):TR=0
1850 PRINT"YOU ARE ALLOWED TO INCREASE YOUR RATE TO ";RT;" PER KILOWATT."
1860 GOTO1910
1870 PRINT"YOUR RATE INCREASE HAS BEEN STUDIED AND ACCEPTED AS REQUESTED"
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1880 RT=PR:TR=0:GOTO1910
1890 PRINT"THE RATE INCREASE YOU REQUESTED HAS BEEN DENIED."
1900 PRINT"NO INCREASE IS ALLOWED."
1910 FORJ=1TO1500:NEXT
1920 TR=TR+1
1930 CLS:PRINT"      ***** END OF YEAR ";YR;" REPORT *****":PRINT
1940 PRINT"INCOME FROM SALE OF POWER          ";:PRINTUSINGD$;ER#
1950 PRINT"POWER PLANTS OPERATED              ";:PRINTUSINGX$;GF
1960 PRINT"MAINTAINENCE COSTS                 ";:PRINTUSINGD$;MN
1970 PRINT"YOU ARE GENERATING AT  ";(KG/GC)*100;"% OF CAPACITY"
1980 PRINT"THE INFLATION RATE FOR THE YEAR WAS     ";(IN*100)-100;"%"
1990 PRINT"THE CONSUMER PRICE INDEX NOW STANDS AT  ";PI
2000 PRINT:PRINT:INPUT"PRESS 'ENTER' TO BEGIN THE NEXT YEAR";Z$
2010 IFYR<10GOTO590
2020 CLS:PRINT"     ***** ENDING FINANCIAL REPORT *****":PRINT
2030 PRINT"GENERATING PLANTS OWNED            ";:PRINTUSINGX$;GF
2040 PRINT"NUMBER OF CUSTOMERS                ";:PRINTUSINGX$;CS
2050 PRINT"TONS OF COAL IN STOCK              ";:PRINTUSINGX$;CL
2060 PRINT"BARRELS OF FUEL OIL IN STOCK       ";:PRINTUSINGX$;FO
2070 PRINT"CASH RESERVE                       ";:PRINTUSINGD$;CR#
2080 PRINT:PRINT"     **************************************"
2090 PRINT:PRINT:INPUT"PRESS 'ENTER' FOR COMMENTS ";Z$:CLS
2100 PRINT"CONGRATULATIONS!  YOU LASTED THE 10 YEARS."
2110 AS=((GF-1)*40000+CR+CL*25+FO*25)*PI
2120 IFAS>1000000*PI*.95GOTO2160
2130 PRINT"YOU SURVIVED AND THAT WAS ALL.  YOUR ASSETS DID NOT GROW AS"
2140 PRINT"FAST AS INFLATION.  INSTEAD OF BEING A MEMBER OF THE BOARD OF"
2150 PRINT"DIRECTORS, YOU HAVE BEEN GIVEN A POSITION AS A JANITOR.":GOTO222
2160 IFAS>1000000*PI*1.1GOTO2190
2170 PRINT"YOU KEPT PACE WITH INFLATION.  YOU HAVE BEEN GIVEN THE POSITION"
2180 PRINT"AS MEMBER OF THE BOARD OF DIRECTORS.":GOTO2220
2190 PRINT"NOT ONLY ARE YOU APPOINTED A MEMBER OF THE BOARD OF DIRECTORS"
2200 PRINT"BUT YOU HAVE BEEN MADE CHAIRMAN OF THE BOARD AND AS A BONUS"
2210 PRINT"YOU HAVE BEEN GIVEN A YEAR'S SUPPLY OF SMELLY CIGARS."
2220 END
```

```
WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT? 1

+--++--++--++--++--++--++--++--+

***** FINANCES FOR BEGINNING OF YEAR  1  *****
GENERATING PLANTS OWNED                      1
NUMBER OF CUSTOMERS                        700
TONS OF COAL IN STOCK                    1,600
BARRELS OF FUEL OIL IN STOCK             2,500
CASH RESERVE                     $1,000,000.00
PEOPLE PROMISE TO CONSERVE.  DEMAND WILL NOT RISE AS SHARPLY
THIS YEAR.

      686,699 KILOWATTS ARE NEEDED.  YOU HAVE  1  PLANTS.
HOW MANY KILOWATTS FROM PLANT  1  680000
PLANT  1  NEEDS  1167  TONS OF COAL.

YOU DID NOT GENERATE ENOUGH TO MEET DEMANDS.
$ 2268.77  DOLLARS WORTH OF DAMAGE HAS BEEN CAUSED TO THE
EQUIPMENT.  FORTUNATELY THIS WAS NOT A FATAL MISTAKE.
FUEL REQUIREMENTS
 1167  TONS OF COAL
 0  BARRELS OF FUEL OIL
COST PER TON OR BARREL        SHIPPING       TOTAL COST
COAL       $22.20               $3.77             $25.97
FUEL OIL   $27.75               $1.77             $29.52
HOW MANY TONS OF COAL DO YOU WISH TO BUY?  1500
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY?  200

 COSTS          COAL           FUEL OIL       TOTAL
               $38,955.00      $5,904.00     $44,859.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A
PLANT.  IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY.  ALL
PLANTS MUST BE DONE AT THE SAME TIME.
PLANT              COST                INCREASE IN EFFICIENCY
 1                $5,716.50                       2.91262  %
TOTAL COST        $5,716.50
DO YOU WISH TO REMODEL?  1=YES  2=NO  2

 COAL GENERATING PLANT WILL COST              $53,174.60
A FUEL OIL GENERATING PLANT WILL COST          $35,217.00
DO YOU WISH TO BUILD A NEW PLANT?  1=COAL  2=FUEL OIL  3=NEITHER  2

DO YOU WISH TO APPLY FOR A RATE INCREASE?  1=YES  2=NO  1
IT HAS BEEN  0  YEARS SINCE YOU HAD A RAISE.
CUSTOMERS ARE PRESENTLY PAYING  .05   PER KILOWATT.
HOW MUCH DO YOU WISH TO CHARGE PER KILOWATT?   .06
THE RATE INCREASE YOU REQUESTED HAS BEEN DENIED.
NO INCREASE IS ALLOWED.


      ***** END OF YEAR  1  REPORT *****
INCOME FROM SALE OF POWER                $34,000.00
MAINTAINENCE COSTS                       $13,320.00
YOU ARE GENERATING AT   68 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS      11 %
THE CONSUMER PRICE INDEX NOW STANDS AT   1.11
```

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+--++--++--++--++--++--++--++--+

   ***** FINANCES FOR BEGINNING OF YEAR  2  *****
GENERATING PLANTS OWNED                       2
NUMBER OF CUSTOMERS                         763
TONS OF COAL IN STOCK                     1,933
BARRELS OF FUEL OIL IN STOCK              2,700
CASH RESERVE                        $940,604.03

      800,000 KILOWATTS ARE NEEDED.  YOU HAVE  2  PLANTS.
HOW MANY KILOWATTS FROM PLANT  1  750000
PLANT  1  NEEDS  1391  TONS OF COAL.

       50,000 KILOWATTS ARE NEEDED.  YOU HAVE  2  PLANTS.
HOW MANY KILOWATTS FROM PLANT  2  50000
PLANT  2  NEEDS  151  BARRELS OF OIL.
FUEL REQUIREMENTS
 1391  TONS OF COAL
 151  BARRELS OF FUEL OIL
COST PER TON OR BARREL        SHIPPING       TOTAL COST
COAL       $23.75               $3.08             $26.83
FUEL OIL   $29.69               $2.01             $31.70
HOW MANY TONS OF COAL DO YOU WISH TO BUY?  1500
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY?  300

L COSTS          COAL           FUEL OIL       TOTAL
               $40,245.00      $9,510.00     $49,755.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A
PLANT.  IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY.  ALL
PLANTS MUST BE DONE AT THE SAME TIME.
PLANT              COST                INCREASE IN EFFICIENCY
 1                $6,605.99                       10.1043  %
 2                $6,176.04                       3.84615  %
TOTAL COST        $12,782.00
DO YOU WISH TO REMODEL?  1=YES  2=NO  2

 GENERATING PLANT WILL COST              $58,685.40
A FUEL OIL GENERATING PLANT WILL COST          $39,078.90
DO YOU WISH TO BUILD A NEW PLANT?  1=COAL  2=FUEL OIL  3=NEITHER  2

DO YOU WISH TO APPLY FOR A RATE INCREASE?  1=YES  2=NO  2

      ***** END OF YEAR  2  REPORT *****
INCOME FROM SALE OF POWER                $40,400.00
MAINTAINENCE COSTS                       $20,939.20
YOU ARE GENERATING AT   40.4 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS      7.00001 %
THE CONSUMER PRICE INDEX NOW STANDS AT   1.1877


+--++--++ -++--++--++--++--++--+

   ***** FINANCES FOR BEGINNING OF YEAR  3  *****
GENERATING PLANTS OWNED                       3
NUMBER OF CUSTOMERS                         808
TONS OF COAL IN STOCK                     2,042
BARRELS OF FUEL OIL IN STOCK              2,849
CASH RESERVE                        $871,230.98
PEOPLE PROMISE TO CONSERVE.  DEMAND WILL NOT RISE AS SHARPLY
THIS YEAR.

      813,599 KILOWATTS ARE NEEDED.  YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  1  800000
PLANT  1  NEEDS  1557  TONS OF COAL.

       13,599 KILOWATTS ARE NEEDED.  YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  2  13599
PLANT  2  NEEDS  36  BARRELS OF OIL.

            0 KILOWATTS ARE NEEDED.  YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  3  0
PLANT  3  NEEDS  0  BARRELS OF OIL.
FUEL REQUIREMENTS
 1557  TONS OF COAL
 36  BARRELS OF FUEL OIL
COST PER TON OR BARREL        SHIPPING       TOTAL COST
COAL       $26.36               $3.16             $29.52
FUEL OIL   $32.95               $2.50             $35.45
HOW MANY TONS OF COAL DO YOU WISH TO BUY?  1200
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY?  300

UEL COSTS          COAL           FUEL OIL       TOTAL
                 $35,424.00     $10,635.00     $46,059.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A
PLANT.  IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY.  ALL
PLANTS MUST BE DONE AT THE SAME TIME.
PLANT              COST                INCREASE IN EFFICIENCY
 1                $7,699.28                       14.385  %
 2                $7,061.07                       6.64674  %
 3                $6,987.24                       5.66037  %
TOTAL COST        $21,747.60
DO YOU WISH TO REMODEL?  1=YES  2=NO  1
```

```
 COAL GENERATING PLANT WILL COST            $62,720.40
A FUEL OIL GENERATING PLANT WILL COST         $40,719.80
DO YOU WISH TO BUILD A NEW PLANT?  1=COAL  2=FUEL OIL  3=NEITHER  3

DO YOU WISH TO APPLY FOR A RATE INCREASE?  1=YES  2=NO  1
IT HAS BEEN  2  YEARS SINCE YOU HAD A RAISE.
CUSTOMERS ARE PRESENTLY PAYING  .05   PER KILOWATT.
HOW MUCH DO YOU WISH TO CHARGE PER KILOWATT?   .06
YOUR RATE INCREASE HAS BEEN STUDIED AND ACCEPTED AS REQUESTED


      ***** END OF YEAR  3  REPORT *****
INCOME FROM SALE OF POWER                   $40,679.95
MAINTAINENCE COSTS                          $30,427.50
YOU ARE GENERATING AT   27.12 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS      11 %
THE CONSUMER PRICE INDEX NOW STANDS AT   1.31835


+--++--++--++--++--++--++--++--+


 ***** FINANCES FOR BEGINNING OF YEAR  4  *****
GENERATING PLANTS OWNED                        3
NUMBER OF CUSTOMERS                          904
TONS OF COAL IN STOCK                      1,685
BARRELS OF FUEL OIL IN STOCK               3,113
CASH RESERVE                         $813,676.90

      976,000 KILOWATTS ARE NEEDED.   YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  1  900000
PLANT  1  NEEDS  1650  TONS OF COAL.

       76,000 KILOWATTS ARE NEEDED.   YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  2  50000
PLANT  2  NEEDS  136  BARRELS OF OIL.

       26,000 KILOWATTS ARE NEEDED.   YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  3  26000
PLANT  3  NEEDS  68  BARRELS OF OIL.
FUEL REQUIREMENTS
 1650  TONS OF COAL
 204  BARRELS OF FUEL OIL
COST PER TON OR BARREL        SHIPPING        TOTAL COST
COAL       $27.42               $5.89              $33.31
FUEL OIL   $34.27               $2.60              $36.87
```

```
HOW MANY TONS OF COAL DO YOU WISH TO BUY?  1000
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY?  500

FUEL COSTS         COAL          FUEL OIL       TOTAL
                $33,310.00    $18,435.00    $51,745.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A
PLANT.  IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY.  ALL
PLANTS MUST BE DONE AT THE SAME TIME.
PLANT              COST                   INCREASE IN EFFICIENCY
 1               $7,540.94                            9.09091  %
 2               $7,472.39                            8.25688  %
 3               $7,129.62                            3.84615  %
TOTAL COST      $22,143.00
DO YOU WISH TO REMODEL?  1=YES  2=NO  2

AL GENERATING PLANT WILL COST             $68,067.30
A FUEL OIL GENERATING PLANT WILL COST         $41,763.10
DO YOU WISH TO BUILD A NEW PLANT?  1=COAL  2=FUEL OIL  3=NEITHER  3

DO YOU WISH TO APPLY FOR A RATE INCREASE?  1=YES  2=NO  2

      ***** END OF YEAR  4  REPORT *****
INCOME FROM SALE OF POWER                   $58,560.00
MAINTAINENCE COSTS                          $32,960.80
YOU ARE GENERATING AT   32.5333 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS      4 %
THE CONSUMER PRICE INDEX NOW STANDS AT   1.37100


--++--++--++--++--++--++--++--+


   ***** FINANCES FOR BEGINNING OF YEAR  5  *****
GENERATING PLANTS OWNED                        3
NUMBER OF CUSTOMERS                          976
TONS OF COAL IN STOCK                      1,035
BARRELS OF FUEL OIL IN STOCK               3,409
CASH RESERVE                         $787,531.12

    1,054,000 KILOWATTS ARE NEEDED.   YOU HAVE  3  PLANTS.
HOW MANY KILOWATTS FROM PLANT  1  900000
YOU DO NOT HAVE ENOUGH COAL.
YOU HAVE MISMANAGED YOUR FUEL INVENTORY.   THAT IS TOO BAD, FOR
YOU WERE DOING FINE IN OTHER AREAS OF MANAGEMENT.   BUT THE
BOARD OF DIRECTORS WERE UNSYMPATHETIC, YOU WERE CANNED.
```

LET IT ALL HANG OUT!
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COMPUTER BUM
I'd rather be playing spacewar
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creative computing

Building a Mouse

Jerry W. Lee

Does The Name Pavlov Ring A Bell?

The theory of learning has been central to experimental psychology since Pavlov's dogged experiments over fifty years ago. Some theorists (like Hull and, more recently, Skinner) think learning theory covers all behavior, and that such areas of psychology as perception, personality and human motivation can eventually be predicted and controlled within its framework.

To the learning theorist, every organism is always in a "learning" situation; but starkly simplified learning experiments, like running mice through mazes, are seen as the clearest way to experiment in this field. Learning takes place when reward (or "reinforcement") occurs; under reinforcement, the organism becomes more likely to emit a certain "behavior." Punishment, or negative reinforcement, doesn't work as well.

Enough said. Here's a simplified mouse you can train all you like. But be aware that while *you* are training *it*, *it* is training *you*. —TN

Most people would be happy to get rid of mice. Our problem was a lack of them — or rather the space, supplies, and time necessary to raise them for use in an introductory psychology class. One of the most effective ways of teaching students the basic principles of learning is to give them actual "hands on" experience in training an animal. Mice, or more frequently rats, are used for this purpose because they take up little space, are relatively easy to raise, and learn relatively rapidly. Nevertheless, when one has four or five hundred students a year taking introductory psychology, the cost of raising and caring for enough mice or rats for all of these students is prohibitive. It is a rare psychology department that can afford such an expensive learning aid.

Computers, on the other hand, do not have to be fed or cleaned up after, and can easily be taught. While their initial cost is high, their upkeep is low (compared to that of a rat colony), and they can do many other things besides run mazes or push bars in a Skinner box.

For these reasons I decided to attempt to develop a computer program to simulate a mouse which could then be trained by students using our PDP 11/40, under the RSTS-E time sharing system. The program would be written in DEC Basic -PLUS. I decided to call the simulation a mouse simulation rather than a rat simulation simply because mice have received much better press than rats.

The "brain" of a computer is well understood. It has to be, since humans manufacture it. But the brain of a mouse is quite complex, in comparison to a digital computer, and is not at all well understood. No one so far has succeeded in developing a computer program that can simulate all the behavior of a mouse. Any computer program which was developed to simulate a mouse would have to be far more limited in its repertoire of possible behavior.

I decided that the mouse simulated would be a very simple one. It would only engage in nine "behaviors." The mouse would be represented by an M on a CRT screen — graphics terminals were not available at the time — and would be able to move up or down, right or left, or on any of the four diagonals. The ninth behavior would be remaining in the same place. This, then, was the original conception of the mouse. As programming continued, other elements were added to the original conception until the current version was developed.

To reinforce the student's behavior, a word such as "YUM," "MMM!", or "SLURP" briefly appears on the screen in the place of the mouse whenever the student reinforces the mouse.

In any training situation there must be a goal or a series of sub-goals. For our mouse, the goal is to receive reinforcement and/or avoid punishment. For our students, the goal is to give the mouse a series of reinforcements and/or punishments until the mouse learns to move to the left and reaches a goal represented by a row of G's along the left side of a CRT screen.

Jerry W. Lee, Department of Psychology, Loma Linda University, Riverside, CA 92515.

For your Apple II....

MUSIC & GRAPHICS

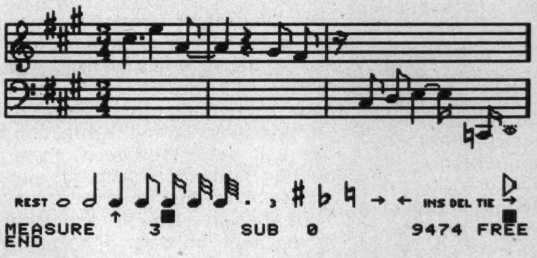
ALF Music Synthesizer

The ALF music synthesizer has three voices on each board which are easily programmed using the Entry program provided. The envelope shape of each voice (or even each note) may be controlled individually thus allowing the synthesis of practically any instrument such as a violin, trumpet, piano, harp or bells. Instrumentation and dynamics may be varied while a song is playing by changing the attack, sustain, release, decay, gap and volume of the notes.

Playback of music is accompanied by a spectacular color display showing a stylized "piano keyboard" for each part with the colors of the notes varying in proportion to their loudness and waveform.

Ease of Music Entry

Music is entered directly using the high-resolution graphics entry program. One paddle is used to select menu items such as note duration, accidentals, dotted notes, triplets, tied notes, etc. while the other paddle moves a note cursor up and down the staff over a 4-octave range. The transpose command extends the range to eight octaves. This form of music entry is considerably faster and more accurate than cryptic note code schemes (like QFS3) found with other synthesizers.



```
MEASURE     3        SUB  0         9474 FREE
END
SAVE
```

MUSIC ENTRY SCREEN

Advanced Features

The Entry program also permits easy editing of previously-entered music including insert, delete and change. New parts may be added (up to nine—3 parts per board). "Subroutines" can be used for repeated parts, codas, and fugues.

The board plugs into any Apple II or Apple II Plus. Two or three boards are required for stereo. Requires a 16K Apple system and external amplifier and speakers.

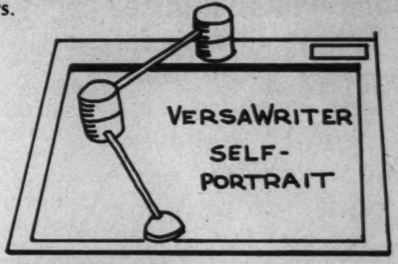
> "Phil Tubb's ALF music board sets high standards in ease of music entry, stereo output and overall flexibility."
> Creative Computing Magazine,
> June 1979

Six music disks will be available in June.

VersaWriter

VersaWriter is a drawing tablet for the creation of full-color, high resolution graphic images on the Apple. Images may be drawn freehand or traced from existing images (cartoons, photos, drawings, etc.) using the simple pivoted two-arm pantograph with magnifying crosshairs.

After an image is drawn, it may be rotated, shrunk, or enlarged. It may be moved across the screen and alternated with other images thus providing high-resolution animation. The image may be colored with varied colors.



Animate other Programs

Graphical images made with VersaWriter and stored on tape or disk may be called from other programs or even imbedded in them. With VersaWriter, you don't have to worry about assembly code, counting pixels or other cumbersome hi-res graphics entry and retrieval techniques.

VersaWriter graphics can be used in all types of programs—games, statistics, engineering, artistic, and educational. Your only limit is your own imagination.

Two Disks of Software

Disk 1 contains the basic plotting, scaling, movement, rotation, color, transfer and recall software. This disk also includes routines which create "shape tables" from your figures to be used in other programs. Disk 2 contains applications software. One program adds five sizes of upper and lower case text to drawings, another adds standard electronic and digital symbols, while a third calculates distances and areas.

VersaWriter requires a 32 or 48K disk system, Applesoft in ROM or an Apple II Plus.

VersaWriter	$252.00
ALF Music Synthesizer	$268.00
ALF/Applesoft Software	15.00

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Mouse, cont'd...

Several constraints were placed on the mouse's behavior. First, the mouse had to react visibly when reinforced or punished by the student. This was necessary in order to reinforce the student's behavior. The visible reaction is accomplished by having a word such as "YUM," "MMM!", or "SLURP" briefly appear on the screen in the place of the mouse whenever the student reinforces the mouse. Words such as "UGH," "OUCH," and "SCREECH" appear when the student punishes the mouse. The student delivers reinforcement to the mouse by pushing the return key on the keyboard. A punishment is delivered whenever the student presses the space bar.

As noted earlier, MOUSE is a rather limited mouse. It will behave like a real mouse only when reinforcement occurs for every correct behavior (continuous ratio reinforcement) or punishment occurs for every incorrect behavior.

A second constraint on the mouse's behavior was that it had to become more eager to behave when being reinforced, and less eager when being punished. The point of this was to teach students the difficulty of using punishment to train animals to *do* something rather than *not do* something. The problem is that in using punishment to train someone to do something, you must punish all behaviors except the correct behavior. In the process an organism may become reluctant to behave at all, because behavior frequently results in punishment.

A third constraint on the mouse was that the mouse shall have a comparatively short short-term memory. One of the clearest findings in the learning literature is that the sooner reinforcement for punishment occurs after a behavior is emitted the more quickly the behavior is learned. Thus our mouse was constructed so that if a student did not reinforce or punish the mouse promptly (within one second) when it behaves, the behavior reinforced or punished is sitting in one place. Thus, delays in reinforcement result in the mouse learning to sit still. Delays in punishment result in the mouse learning to move, but learning to move in a random manner.

The Learning Algorithm

Since this mouse was to be a simple one, a simple learning algorithm was devised. A simplified version of the overall algorithm is presented in Figure 1 and Figure 2. (Since this flowchart is intended to clarify the method by which the mouse learns, it does not include the routines that implement the first and second constraints discussed above, or the provision for a "smart" or "dumb" mouse, or the end routine.) For information about these routines you may consult the program itself, which accompanies this article.

The mouse's learning is handled in the following way: A set of sixty memory locations in the computer are randomly assigned the numbers one through nine. These numbers represent the mouses' nine possible behaviors. The computer randomly selects one of the sixty memory locations. If the behavior represented by the mouse does not move the mouse off the CRT screen, then the computer mouse engages in the indicated behavior. If the mouse reaches the goal the training trial is terminated. If reinforcement occurs within one second, the mouse enters the reinforcement subroutine. If punishment occurs, the mouse enters the punishment subroutine. These subroutines will be discussed later. If reinforcement occurs after one second has elapsed, but prior to the expiration of a short wait before the next behavior, the reinforcement subroutine is entered — but the behavior reinforced is "sitting in the same place." If punishment occurs after one second has elapsed, but prior to the expiration of a short wait before the next behavior, then the punishment subroutine is entered — but the behavior punished is "sitting in the same place." If no reinforcement or punishment occurs prior to the expiration of the second wait, then the extinction subroutine is entered. Entry into the punishment or reinforcement subroutine causes the program to enter another wait of variable length (W1% seconds). If reinforcement or punishment occurs during this wait, the behavior reinforced or punished is "sitting," and the wait begins again. If no reinforcement or punishment occurs, then a new memory location from the sixty-element array is selected and the sequence begins again. This last wait, and the reinforcement or punishment of sitting, are necessary to prevent over-eager students from speeding up the mouse by simply terminating each random wait period by delivering reinforcers or punishers.

It may be helpful, at this point, to explain the concept of a wait. WAIT is a statement in DEC Basic-PLUS which causes the computer to wait for input a specified number of seconds. If no input occurs before the specified number of seconds expires, then a trappable error occurs. An error subroutine can then be used to tell the computer what to do in that case.

The reinforcement subroutine. The steps that take place when this subroutine is entered are as follows. The sixty-element memory array is searched *n* times. The value for *n* depends on the smartness-level of the mouse selected by the students. The object of each search is to find numbers representing behaviors which are *not* similar to or identical with the behavior just engaged in.

If reinforcement occurs after one second has elapsed, the reinforcement subroutine is entered — but the behavior reinforced is "sitting in the same place."

Suppose that the mouse had been reinforced for moving directly to the left. Movements diagonally upward and to the left or diagonally downward and to the left would be similar to the reinforced behavior. Once the routine finds a number representing a behavior not similar to the direction that has just been reinforced, then this number is replaced with the number representing the reinforced behavior. Thus the sixty-element array becomes increasingly loaded with behaviors similar to those which have been reinforced. Since behaviors similar to the reinforced behavior are not replaced by this method, the result also weights the array to simulate some generalization of response. The program then enters the wait-state described earlier.

In addition, the maximum wait of the mouse before the next behavior occurs is decreased if the minimum wait has not been reached. This causes the mouse to appear more "eager" to behave.

The punishment subroutine. The action of the punishment subroutine is very similar to the action of the reinforcement routine. The computer makes *n* searches through the sixty-element array until a number representing a behavior identical with the behavior punished is found. This number is then replaced with a number which is *not* similar to or identical with

Mouse, cont'd...

the number representing the behavior punished. If the maximum wait has not already been reached, the mouse's wait before the next behavior is also increased, so that the mouse appears more "reluctant" to behave.

The extinction subroutine. The extinction subroutine is very simple in action. A number between one and nine (representing one of the nine behaviors) is randomly selected and this number is inserted into the memory location which held the most recent behavior engaged in by the mouse. If no reinforcement or punishment occurs for a number of trials, the mouse will gradually "forget" what it has learned.

Use of the Program

The mouse is usually used as an outside assignment for students. Since the program will run in a time-sharing environment, many students can run the program simultaneously. Students are given a handout describing how to operate the computer to run the mouse simulation. They are then asked to train several mice with punishment, several with reward, and to record the amounts of time, and numbers of trials, reinforcements, and punishments needed to train each mouse. They are then asked to read the text material on learning, to describe the differences they found under conditions of reinforcement and punishment, and to discuss why these differences exist and what sort of learning is actually occurring.

As in real life, the performance of the mouse is almost invariably worse with punishment than with reward.

As in real life, the performance of the mouse is almost invariably worse with punishment than with reward. The three most common (correct) reasons that students give for this fact are:

1. Punishing the mouse's movement in the wrong direction also punishes movement in general so the mouse becomes less willing to move.
2. Students tend only to punish behaviors which move the mouse away from the goal; irrelevant movements, such as moving up or down, are not punished. Thus it takes longer for the mouse to learn with punishment because it engages in more irrelevant behavior.
3. When the mouse is moving toward the goal nothing happens to it. Thus, the mouse will gradually forget what it has learned. Extinction sets in.

Students generally report that they find the computer experience enjoyable. MOUSE has been in use for approximately 18 months and is believed to be relatively bug-free.

Limitations

As noted earlier, MOUSE is a rather limited mouse. It will behave like a real mouse only when reinforcement occurs for every correct behavior (continuous ratio reinforcement) or punishment occurs for every incorrect behavior. If more complex reinforcement is attempted — for example, reinforcing every third correct behavior (fixed ratio three), then MOUSE's behavior will not duplicate that of a real mouse. In addition, MOUSE's learning curve for continuous-ratio reinforcement does not exactly duplicate that of a real mouse. These problems are being worked on and a possible solution is being attempted. Nevertheless, the current version of MOUSE does serve a useful function in the general psychology lab, in causing students to think about the differences between reinforcement and punishment. □

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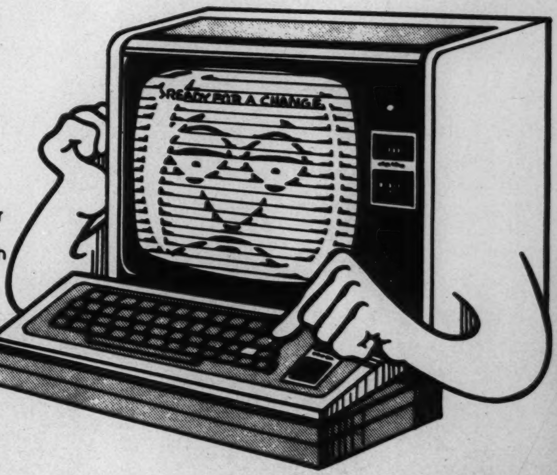
CIRCLE 113 ON READER SERVICE CARD



```
5 !
!         M O U S E   --   A   S I M U L A T I O N
!
!       F O R    G E N E R A L    P S Y C H O L O G Y
!
!             COPYRIGHT 1979 BY JERRY W. LEE

10      RANDOMIZE

15      ON ERROR GO TO 810

20      DIM M%(61%),R$(6%),P$(6%),B$(9%)
        ! M%() = MOUSE'S MEMORY.
        ! R$() = REINFORCEMENT WORDS.
        ! P$() = PUNISHMENT WORDS.
        ! B$() = BEHAVIORS IN THE FORM OF CURSOR MOVEMENT COMMANDS.

30      DATA " OUCH! ","  UGH  "," EEEK! "," GRUNT ","SCREECH","@*$#%&!"

50      READ P$(I%) FOR I%=1% TO 6%

60      DEF FNR1%=9%*RND(0)+1%
        ! RANDOM NUMBER REPRESENTING ONE OF NINE BEHAVIORS.

64        R2% = 2%
        \ P2% = 4%
        \ W3% = 8%
        \ N1% = 60%
        \ W4% = 80%
        \ G%  = 12%
        \ W%  = 1%
        \ M3% = 5%
        ! REINFORCEMENT SMARTNESS (LARGER NUMBER MAKES SMARTER).
        ! PUNISHMENT SMARTNESS.
        ! MAXIMUM WAIT TO SIT (IN SEC.).
        ! SIZE OF MOUSE'S MEMORY
        ! WIDTH OF CRT SCREEN IN CHARACTERS.
        ! NUMBER OF LINES ON CRT SCREEN
        !AMOUNT TO WAIT FOR REINF. OR PUNISH. BEFORE TRANSFERING TO
                SIT ROUTINE.
        ! SIZE OF LEFT OR RIGHT MOVE.

66      R2%=2% IF R2%<2%
        \ P2%=2% IF P2%<2%

80      DEF FNR2%=N1%*RND(0)+1%
        ! OBTAINS RANDOM NUMBER TO SELECT MEMORY LOCATION IN M%().

90      DATA"SMACK","YUM! ","CHOMP","BURP!","MMM!!","SLURP"

110     READ R$(I) FOR I=1 TO 6

120     PRINT CHR$(155%)+'H'+CHR$(155%)+'J'
        ! HOME AND CLEAR SCREEN.
```

```
130     PRINT"THIS PROGRAM IS DESIGNED TO SIMULATE";
        \ PRINT" THE OPERANT CONDITIONING OF A MOUSE."
        \ PRINT"THE OBJECT IS TO GET THE MOUSE TO";
        \ PRINT" GO TO THE GOAL BY REINFORCING THE CORRECT"

135     PRINT"RESPONSES AND/OR PUNISHING INCORRECT RESPONSES.";
        \ PRINT"  THE MOUSE IS REPRESENTED BY"
        \ PRINT"THE LETTER M.  THE GOAL IS REPRESENTED BY A LINE OF G'S."

140     PRINT"TO REINFORCE THE MOUSE PUSH THE RETURN ";
        \ PRINT"KEY WITHIN ONE SECOND AFTER HE MOVES."
        \ PRINT"TO PUNISH HIM PUSH THE SPACE BAR.  IF YOU TAKE LONGER";
        \ PRINT " THAN A SECOND YOU MAY"

145     PRINT"CONFUSE THE MOUSE."

150     L$=CHR$(8%)
        \ R$=CHR$(155%)+'C'
        \ U$=CHR$(155%)+'A'
        \ D$=CHR$(10%)
        \ B$=CHR$(13%)
        \ H$=CHR$(155%)+'H'
        \ C$=CHR$(155%)+'J'
        \ E$=CHR$(155%)+'K'
        ! ** CURSOR CONTROL FUNCTIONS **
        ! L$ = LEFT.
        ! R$ = RIGHT.
        ! U$ = UP.
        ! D$ = DOWN.
        ! H$ = HOME.
        ! C$ = CLEAR TO END OF SCREEN.
        ! E$ = ERASE TO END OF LINE.

210     S$=L$+" "+L$
        ! IF PRINTED ERASES MOUSE AND PLACES CURSOR IN MOUSE'S FORMER
                POSITION.

230     B$(4%)=S$
        \ B$(8%)=S$

240     FOR I%=1% TO M3%
        \ B$(4%)=B$(4%)+R$
        \ B$(8%)=B$(8%)+L$
        \ NEXT I%
        ! LOOP PUTS IN RIGHT OR LEFT COMPONENT OF BEHAVIOR.

250     B$(1%)=B$(8%)+U$
        \ B$(2%)=S$+U$
        \ B$(3%)=B$(4%)+U$
        \ B$(5%)=B$(4%)+D$
        \ B$(6%)=S$+D$
        \ B$(7%)=B$(8%)+D$
        \ B$(9%)=S$+S$+S$+S$+S$
        \ B$(9%)=B$(9%)+"     "
        ! INSTALL BEHAVIORS.
        ! 1 = LEFT & UP.
        ! 2 = UP.
        ! 3 = RIGHT & UP.
        ! 4 = RIGHT.
        ! 5 = RIGHT & DOWN.
        ! 6 = DOWN.
        ! 7 = LEFT & DOWN.
        ! 8 = LEFT.
        ! 9 = REMAIN IN SAME PLACE.

320     OPEN "KB: " AS FILE 1%

340     M%(I%)=FNR1% FOR I%=1% TO N1%
        \ W1%=(W3%-1%)/2%
        \ W1%=1% IF W1%<=0%
        ! RANDOMIZE MOUSE'S MEMORY
        ! SET VALUE OF STANDARD WAIT TO HALF MAXIMUM.

350     PRINT
        \ INPUT"DO YOU WANT A SMART MOUSE OR A DUMB MOUSE";S$

360     IF S$="S"THEN S9%=-1%
        \ GO TO 390
        ! S9% = SMART FLAG = -1 FOR SMART MOUSE = 0 OTHERWISE.

370     IF S$="D" THEN S9%=0%
        \ GO TO 390

380     PRINT"TYPE AN S OR A D PLEASE."
        \ GO TO 350

390     PRINT
        \ M% = 0%
        \ R% = 0%
        \ P1%= 0%
        \ INPUT"PUSH THE RETURN BUTTON TO START THE GAME";Q$
        ! PRINT A LINE.
        ! ZERO MOVE COUNTER.
        ! ZERO REINFORCEMENT COUNTER.
        ! ZERO PUNISHMENT COUNTER.
        ! START GAME.

400     PRINT H$+C$
        ! HOME & CLEAR.

410     !

        B E G I N   S I M U L A T I O N

430     PRINT 'G' FOR I%=1% UNTIL I%>=G%-1%
        ! PRINT GOAL.

450     D1$=''
        \ D1$=D1$+D$ FOR I%=1% TO G%/2%
        \ PRINT H$;D1$;'G';TAB(25%);
        ! MOVE CURSOR TO APPROX. MIDDLE OF SCREEN.

460     S$=SYS(CHR$(3%))
        ! TURN OFF TERMINAL ECHOING.

470     PRINT "LET'S START.  HERE'S THE MOUSE."
        ! STARTING SIGN.

480     SLEEP 3%

490     PRINT U$;B$;R$;E$;
        ! ERASE STARTING SIGN.
```

```
500     PRINT B$;
        \ PRINT R$;TAB(60%);
        ! MOVE CURSOR TO MOUSE'S STARTING POSITION.

520     T1=TIME(0%)
        \ H%=60%
        \ V%=G%/2%+1%
        ! T1 = STARTING TIME.
        ! H% = HORIZONTAL POSITION.
        ! V% = VERTICAL POSITION.

540     PRINT "M";

550     GOSUB 1300
        ! SIT FOR AWHILE BEFORE BEHAVING.

555     N2%=FNR2%
        \ N%=M%(N2%)
        \ R1% = 0%
        ! SELECT BEHAVIOR TO TEST
        ! THEN ZERO RESPONSE FLAG (R%)

570     I1%=0
        ! ZERO ILLEGAL BEHAVIOR COUNTER.

590     I1%=I1%+1%
        \ IF I1%>20% THEN M%(N2%)=FNR1%
        \ N%=M%(N2%)
        ! IF MORE THAN TWENTY ILLEGAL BEHAVIORS ARE ARE ATTEMPTED TAKE A
                RANDOM MOVE.
        ! AN ILLEGAL BEHAVIOR ONE WHICH WOULD TAKE THE MOUSE OFF THE SCREEN.

600     ON N% GO TO 610, 620, 630, 640, 650, 660, 670, 680, 720
        ! CHECK FOR LEGALITY OF BEHAVIOR.

610     H1%=-M3%
        \ V1%=-1%
        \ GO TO 690

620     H1%=0%
        \ V1%=-1%
        \ GO TO 690

630     H1%=M3%
        \ V1%=-1%
        \ GO TO 690

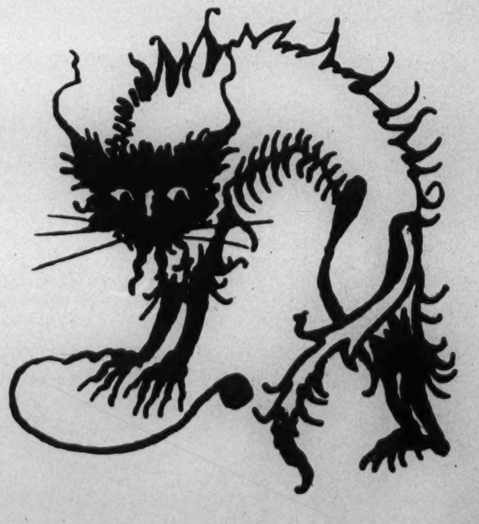
640     H1%=M3%
        \ V1%=0%
        \ GO TO 690

650     H1%=M3%
        \ V1%=+1%
        \ GO TO 690

660     H1%=0%
        \ V1%=+1%
        \ GO TO 690

670     H1%=-M3%
        \ V1%=+1%
        \ GO TO 690

680     H1%=-M3%
        \ V1%=0%
        \ GO TO 690
```



```
690     IF H%+H1%<=1% GO TO 850
        ! IF GOAL HAS BEEN REACHED GO TO END ROUTINE.

700     H2%=H%+H1%
        \ V2%=V%+V1%
        \ IF H2%>=W4% OR V2%>=G% OR V2%<1% THEN N2%=FNR2%
        \ N%=M%(N2%)
        \ GO TO 590
        ! IF SELECTED BEHAVIOR IS ILLEGAL (MOVES MOUSE OFF SCREEN) THEN
                SELECT A NEW BEHAVIOR AND GO TO THE BEGINING OF
                THE TEST ROUTINE.

710     H%=H2%
        \ V%=V2%
        \ M% = M% + 1%
        ! RECORD NEW HORIZONTAL POSITION.
        ! RECORD NEW VERTICAL POSITION.
        ! COUNT MOVE.

720     PRINT B$(N%);"M";
        ! MOUSE BEHAVES !!!

740     WAIT W%
        ! GIVE USER W% SECONDS TO RESPOND TO MOVE.
        ! EXHAUSTED WAIT GOES TO ERROR ROUTINE WHICH RESUMES AT SIT ROUTINE.

770     S$=SYS(CHR$(4%))
        \ S$=SYS(CHR$(11%))
        ! SYS(CHR$(4%)) = SET SINGLE CHARACTER GET MODE.
        ! SYS(CHR$(11%))= CLEAR KEYBOARD BUFFER.

780     FIELD #1%, 10% AS R1$
        \ GET #1%
        \ R1$=LEFT(R1$,1%)
        \ R1%=-1%
        ! GET USER'S RESPONSE.
        ! SET RESPONSE FLAG (R%) TO INDICATE A RESPONSE WAS MADE.

790     IF R1$=CHR$(32%) THEN GOSUB 1030 ELSE GOSUB 1150
        ! IF SPACE BAR HIT GO TO PUNISHMENT ROUTINE OTHERWISE GO TO
                REINFORCEMENT ROUTINE.

794     GOSUB 1300
        ! GO TO SIT SUBROUTINE.
        ! PROGRAM ALSO TRANSFERS TO THIS LINE WHEN WAIT EXHAUSTED ERROR
                OCCURS IN LINE 780.

796     GOSUB 817 IF NOT R1%
        ! GO TO EXTINCTION ROUTINE IF NO RESPONSE FROM USER IN LINE 780.

800     GO TO 555
        ! RETURN TO SELECT ANOTHER BEHAVIOR.

805     !

        ! E R R O R    H A N D L I N G    R O U T I N E S

810     IF ERR<>15 THEN ON ERROR GO TO 0
        ! IF ERROR IS NOT AN EXHAUSTED WAIT THEN TERMINATE PROGRAM.

811     IF ERL=780 THEN RESUME 794
        ! USER DID NOT RESPOND TO BEHAVIOR WITHIN W% SECONDS.

815     IF ERL=1320 THEN RESUME 1350
        ! USER DID NOT RESPOND DURING SIT PERIOD.
```

```
816     ON ERROR GO TO 0
        ! AN UNPLANNED ERROR HAS OCCURED, TERMINATE THE PROGRAM.

817     !

                E X T I N C T I O N    R O U T I N E

820     M%(N2%)=FNR1%
        ! REPLACE LAST USED BEHAVIOR IN MEMORY WITH A RANDOM BEHAVIOR.

840     RETURN
        ! RETURN TO MAIN PROGRAM FOR RETURN
        ! BEHAVIORAL SELECTION ROUTINE.

850     !

                E X I T    R O U T I N E

860     S$=SYS(CHR$(2%))
        ! ENABLE TERMINAL ECHOING

870     PRINT B$(N%);'M';B$;
        \ V%=V%+V1%
        \ M%=M%+1%
        ! MOVE TO GOAL!!!
        ! INCREMENT MOVEMENT COUNTER.

880     FOR I%=1% TO 8%
        \ PRINT H$;
        \ FOR J%=1% TO G%-1%
        \ PRINT D$;' ';L$;
        \ NEXT J%
        ! START GOAL FLASHING LOOP
        ! BLANK OUT GOAL

920     PRINT H$;
        \ FOR J%=1% TO G%-1%
        \ PRINT D$;'G';L$;
        \ NEXT J%
        \ NEXT I%
        ! PRINT GOAL AGAIN
        ! RETURN TO LOOP START AND CONTINUE TO FLASH GOAL 8 TIMES.
950     PRINT H$+C$+D$;TAB(20%);"CONGRATULATIONS"

960     PRINT "THE MOUSE MADE IT TO THE GOAL IN";TIME(0%)-T1;"SECONDS."

970     PRINT "YOU HAVE USED";R%;"REINFORCEMENTS AND";
        \ PRINT P1%;"PUNISHMENTS FOR THIS MOUSE."

980     PRINT "THIS MOUSE HAS MOVED";M%;"TIMES."

990     WAIT 0%
        ! CANCEL WAIT STATE.

1000    INPUT"DO YOU WANT TO TRY AGAIN";Q$
        \ IF LEFT(Q$,1%)="Y" THEN PRINT
        \ PRINT"DO YOU WANT TO USE YOUR OLD MOUSE (TYPE O) ";
        \ INPUT"OF DO YOU WANT A NEW MOUSE (TYPE N)";Q$
        \ IF LEFT(Q$,1%)="N" GO TO 340 ELSE GO TO 390

1005    IF LEFT(Q$,1%)<>"N" THEN PRINT"ANSWER YES OR NO PLEASE."
        \ GO TO 1000

1010    PRINT H$;C$
        ! HOME CURSOR AND CLEAR SCREEN.
```

```
1020    GO TO 4000
        ! GO TO END OF PROGRAM.

1030    !

        ! P U N I S H M E N T    S U B R O U T I N E

1040    PRINT L$;L$;L$;L$;P$(6%*RND(0)+1%);L$;L$;L$;L$;L$;L$;E$;"   M";
        \ P1%=P1%+1%
        ! PRINT RANDOMLY SELECTED PUNISHMENT WORD IN MOUSE'S POSITION
                THEN ERASE AND PRINT MOUSE.
        ! INCREMENT PUNISHMENT COUNTER.

1050    IF S9% THEN J%=P2% ELSE J%=P2%/2%
        ! SET FOLLOWING LOOP TO REPEAT FEWER TIMES FOR DUMB MOUSE.

1060    FOR I%=1% TO J%
        \ FOR K%=1% UNTIL N%=M%(K%)OR K%>N1%
        \ NEXT K%
        ! START LOOP.
        ! FIND BEHAVIOR IN ARRAY EQUAL TO PUNISHED BEHAVIOR

1075    GO TO 1110 IF K%>N1%
        ! IF NO SUCH BEHAVIOR END SEARCH LOOP.

1077    IF N%=9% THEN U%=9%
        \ L%=9%
        \ GO TO 1100
        ! IF BEHAVIOR WAS SITTING SET U% AND L% TO SITTING BEHAVIOR
                NUMBER.

1080    P%=M%(K%)
        \ U%=P%+1%
        \ L%=P%-1%
        \ L%=8% IF L%=0%
        \ IF U%=9% THEN U%=1%
        ! SET U% TO BEHAVIOR ONE MOVE CLOCKWISE FROM PUNISHED BEHAVIOR.
        ! SET L% TO BEHAVIOR ONE MOVE COUNTER-CLOCKWISE.

1100    M%(K%)=FNR1% FOR J1%=1% UNTIL M%(K%)<>P% AND M%(K%)<>U% AND M%(K%)<>L%
        ! INSERT ANY BEHAVIOR INTO MEMORY LOCATION OF BEHAVIOR THAT WAS
                PUNISHED EXCEPT PUNISHED BEHAVIOR OR BEHAVIOR SIMILAR TO
                PUNISHED BEHAVIOR.

1110    NEXT I%
        ! SEARCH AND REPLACE PUNISHED BEHAVIORS J% TIMES.

1120    W1%=W1%+1% IF W1%<W3%
        ! INCREASE WAIT IN SIT ROUTINE IF NOT ABOVE MAXIMUM.

1140    RETURN

1150    !

        ! R E I N F O R C E M E N T    S U B R O U T I N E

1160    PRINT L$;L$;L$;R$(6*RND(0)+1%);L$;L$;L$;L$;L$;E$;"  M";
        \ R%=R%+1%
        ! PRINT RANDOM REINFORCEMENT MOVE IN PLACE OF MOUSE
                THEN ERASE AND REPRINT MOUSE.
        ! INCREMENT REINFORCEMENT COUNTER.

1180    IF S9% THEN E%=R2% ELSE E%=R2%/2%
        !  SET SEARCH LOOP TO REPEAT FEWER TIMES IF MOUSE IS DUMB.

1185    IF N%=9% THEN U%,L
        \ GO TO 1210
        ! IF REINFORCED BEHAVIOR WAS SITTING THEN SET U% AND D%
                TO REPRESENT SITTING BEHAVIOR.

1190    U%=N%+1%
        \ L%=N%-1%
        \ L%=8% IF L%=0%
        \ IF U%=9% THEN U%=1%
        ! SET U% TO ONE MOVE CLOCKWISE TO REINFORCED BEHAVIOR.
        ! SET L% TO ONE MOVE COUNTER-CLOCKWISE.

1210    FOR I%=1% TO E%
        \ FOR J%=1% UNTIL(M%(J%)<>N% AND M%(J%)<>U% AND M%(J%)<>L%) OR J%>=N1%
        \ NEXT J%
        \ M%(J%)=N%
        \ NEXT I%
        ! SEARCH ARRAY FOR BEHAVIOR NOT EQUAL TO OR SIMILAR TO
                REINFORCED BEHAVIOR AND REPLACE WITH REINFORCED
                BEHAVIOR.

1250    IF W1%>0% THEN W1%=W1%-1%
        ! DECREASE WAIT TIME IN SIT ROUTINE IF WAIT IS NOT ALREADY
                AT MINIMUM.

1270    RETURN

1300    !

        ! S I T    S U B R O U T I N E

1310    W1%=1% IF W1%<1%
        \ W2%=2%*INT(RND(0)+.5)-1%
        \ W2%=W2%+W1%
        \ IF W2%<1% THEN W2%=1%
        ! MAKE SURE WAIT WILL NOT BE SET TO ZERO.
        ! ADD A RANDOM AMOUNT TO THE SIT PERIOD.

1320    WAIT W2%
        \ FIELD#1%,10% AS R1$
        \ S$=SYS(CHR$(4%))
        \ S$=SYS(CHR$(11%))
        \ GET #1%
        ! SET WAIT.
        ! DEFINE HOW MUCH TO GET FROM KEYBOARD.
        ! SET SINGLE CHARACTER GET MODE.
        ! CLEAR KEYBOARD BUFFER.
        ! GET A CHARACTER.
        ! IF NO RESPONSE FROM USER IN W2% SECONDS GOES TO ERROR
                ROUTINE WHICH RESUMES AT 1350

1330    R1$=LEFT(R1$,1%)
        \ N%=9%
        \ IF R1$=CHR$(32%) THEN GOSUB 1030 ELSE GOSUB 1150
        ! IF RESPONSE WAS SPACE CHARACTER GO TO PUNISHMENT ROUTINE
                OTHERWISE GO TO THE REINFORCEMENT ROUTINE.

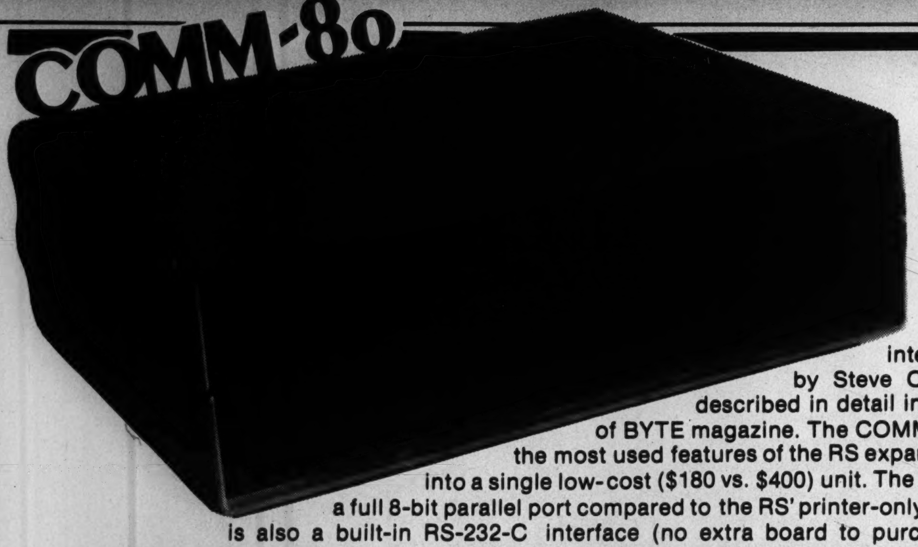
1340    GO TO 1300
        ! REPEATS SIT ROUTINE IF MOUSE WAS REINFORCED OR PUNISHED
                DURING THE SIT.  THIS LINE IS BYPASSED WHEN EXHAUSTED
                WAIT OCCURS IN LINE 1320.

1350    RETURN

4000    END

Ready
```

COMM-80



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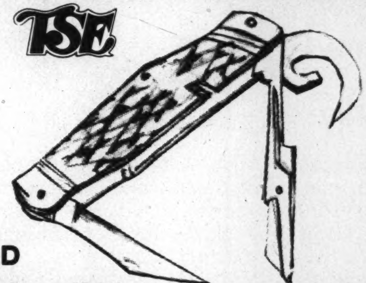

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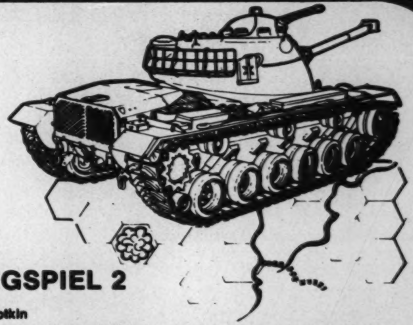

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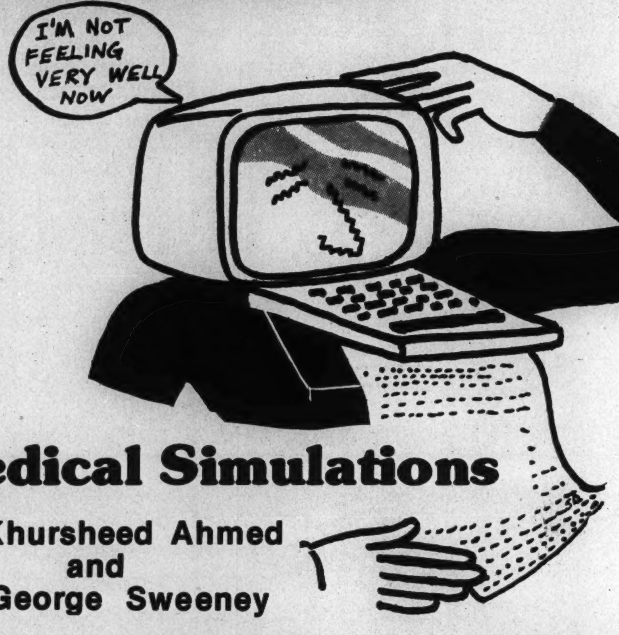

I'M NOT FEELING VERY WELL NOW

Medical Simulations

Dr. Khursheed Ahmed and Dr. George Sweeney

You are traveling in a jet plane at 30,000 feet; suddenly the cabin blows open and atmospheric pressure falls — what happens to your breathing? How does your blood retain enough oxygen? How does the body respond? How long can you survive? In the past, the only way to answer these questions was to perform experiments on willing volunteers, or use animals for experimentation, or simply rely on the facts stated in books. However, with the development of computer simulation techniques, it is now possible to duplicate these experiments without any pain or danger to living beings. In fact, using these tools, medical students in many schools are performing experiments which would be unethical or technically impossible in real life. Such simulations can be very instructive for understanding human physiology and to study how our body responds in states of health and in disease.

You are traveling in a jet plane at 30,000 feet; suddenly the cabin blows open and atmospheric pressure falls—what happens to your breathing? How does your blood retain enough oxygen? How does the body respond? How long can you survive?

Simulation techniques have been used in many other fields, such as space technology, engineering problems, economics, ecology, etc. For example, pilots are routinely trained to fly a jet plane in a flight simulator. However, the application of this concept to medicine and physiology is relatively new. This is partly because physiological systems are very difficult to describe mathematically. We must first determine the laws governing a system and the intricate relationships between all the varying factors, before we can program them into a computer — this is a formidable task. In practice, we build a mathematical 'model' of the system by making some assumptions. We then gradually refine this model and test its predictions against as many known facts as possible until we have achieved a reasonably realistic representation. This is the approach we have taken in developing a series of simulation models of human physiology.

In 1970, Dr. C. J. Dickinson, who came to McMaster University from London as the R. S. McLaughlin visiting professor, decided to attempt a computer simulation of the human heart and circulation of blood in the body. The initial attempts were encouraging and, after some program aborts and the usual debugging steps, a successful program emerged. This abstract creature was named MACMAN. He was soon tamed to allow some basic experiments dealing with loss of blood, heart-attack, hardening of the arteries and other abnormalities. He was also taught enough language to record some of his more serious symptoms as verbal comments. Graphic and numeric data

```
                 ----- NEW (INTACT) SUBJECT -----
XXXX SYSTOLIC AND DIASTOLIC PRESSURES-MM HG '*' HEART RATE-BEATS/MIN

TIME 0  20  40  60  80  100 120 140 160 180 200 220 240 260 280 300
SECS .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
 -28               *XXXXXXXXX
 -24               *XXXXXXXXX
 -20               *XXXXXXXXX
 -16               *XXXXXXXXXX
 -12               *XXXXXXXXXX
  -8              * XXXXXXXXXX
  -4              *XXXXXXXXXX
   0              * XXXXXXXXXX

B.P. SYSTOLIC=121  DIASTOLIC= 75  MEAN=  90.7
RIGHT ATRIAL PRESS.= 1.8 MM HG  MEAN CAPILL.PRESS.=    12.6 MM HG
CARDIAC OUTPUT=  4.9 L/MIN, STROKE VOL.=  68.3 ML, HEART RATE=  72.
ART.RESIST.=  15.9   VENOUS RESIST.=  2.2 MM HG/L/MIN
CARDIAC CONTRACILITY=  1.3 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1..ART. RESISTANCE=  100.0 % OF NORMAL
2..VEN. RESISTANCE=  100.0 % OF NORMAL
3..CARDIAC CONTRACTILITY=  100.0 % OF NORMAL
4..MEAN INTRATHORACIC PRES.=  -2.0 MM HG
5..BLOOD VOLUME=  5000.0 ML
```

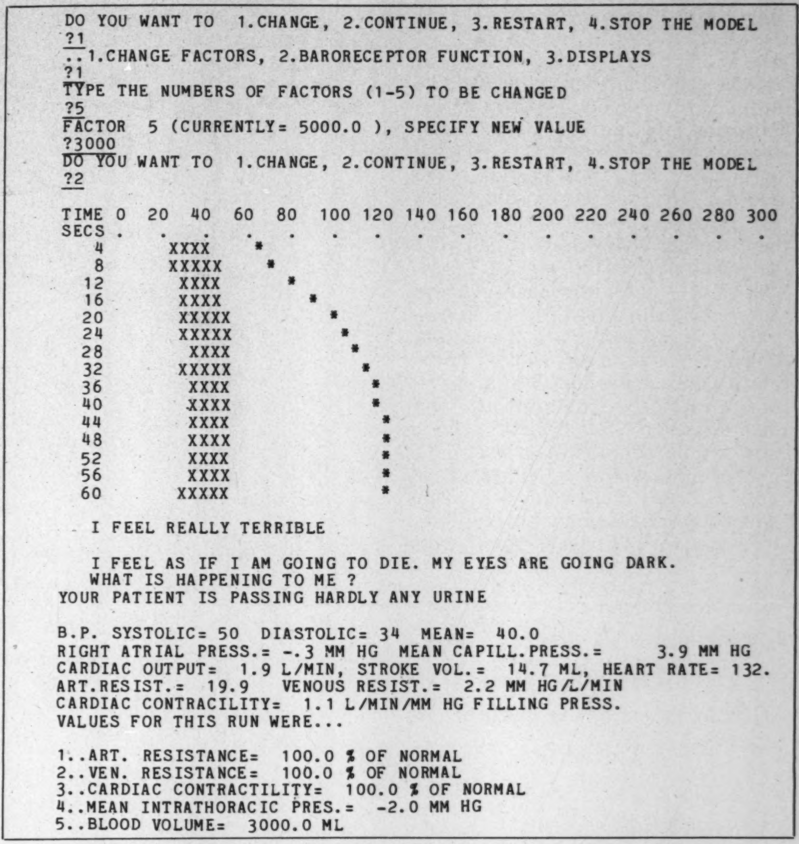
Figure A This is MACMAN in a normal, healthy state. His heart rate is 72 beats/minute, blood pressure is 121/75 mmHg, and he has 5 litres of blood in his body.

Dr. Khursheed Ahmed / Dr. George Sweeney, McMaster University Medical School, Hamilton, Ontario, Canada L85 4J9.

were a natural output from his equations.

A typical encounter with MACMAN is shown in Figures A to D. Figure A shows MACMAN's heart beating normally at 72 beats per minute (shown as symbol*), and maintaining an average blood pressure of 121/75 millimeters of Mercury (mmHg) — systolic/diastolic pressures, shown with symbols XXXXXX. This is the normal 'intact' subject which represents a relatively healthy young adult male at rest weighing about 70 Kg at rest. His total blood volume is 5 litres (about 9.2 pints), and this is approximately equal to the volume pumped through the heart every minute — the cardiac output. We now simulate the effect of a sudden loss of blood of about 2 litres (about 3.7 pints). MACMAN goes into an immediate state of shock (Figure B), and his blood pressure falls to about 40/21 mmHg. It is noted that the heart is not getting enough blood to the kidneys. Various protective reflexes are immediately invoked, including an increase in heart rate, and at the end of one minute you will notice that the heart rate has risen to 132 beats per minute! His blood pressure recovered slightly to a mean value of 50/34 mmHg. But all is not well. He is "not feeling too well" and "his eyes are going dim." If the simulation were allowed to continue for another three minutes, MACMAN would die and we would have a post-mortem report. The first task, therefore, is to elevate and stabilize his blood pressure. You would try an injection of noradrenalin to constrict his arteries (simulated in MACMAN by doubling the arterial resistance). Figure C shows the effect of this drug; his blood pressure has indeed gone up to 97/70 mmHg and his heart has slowed somewhat to 110 beats per minute. MACMAN is "feeling better but not right yet" — he has stabilized and his symptoms have improved. But note that his blood volume is still at the reduced level of 3 litres and his heart is pumping only about 2.1 litres of blood per minute (cardiac output) — not enough to provide the body cells with the necessary nutrients to maintain a healthy state. However, we shall have mercy on the poor soul and relieve his agony by giving him a blood transfusion of 3 units or about 1.6 litres (and at the same time let the arteries return to their normal state). This is shown in Figure D — after an initial imbalance, the blood pressure and heart rate return to very nearly the normal values (shown in Figure A). The heart is pumping away at 4.6 litres per minute and MACMAN is tickled pink — he acknowledges your efforts and is wondering what nasty motives you have next! This example would have given you an idea of how MACMAN can oblige by letting you perform drastic experiments on him and is even willing to "die" many times for the sake of science! Hundreds of similar experiments can be performed by changing the five "factors" in different combinations. These factors are:

We must first determine the laws governing a system and the intricate relationships between all the varying factors, before we can program them into a computer—this is a formidable task.



```
 DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
 ?1
 ..1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS
 ?1
 TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED
 ?5
 FACTOR  5 (CURRENTLY= 5000.0 ), SPECIFY NEW VALUE
 ?3000
 DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
 ?2

 TIME 0  20  40  60  80  100 120 140 160 180 200 220 240 260 280 300
 SECS .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
    4      XXXX    *
    8      XXXXX    *
   12       XXXX      *
   16       XXXX        *
   20       XXXXX         *
   24       XXXXX          *
   28        XXXX           *
   32       XXXXX            *
   36        XXXX             *
   40        XXXX             *
   44        XXXX              *
   48        XXXX              *
   52        XXXX              *
   56        XXXX              *
   60       XXXXX              *

     I FEEL REALLY TERRIBLE

     I FEEL AS IF I AM GOING TO DIE. MY EYES ARE GOING DARK.
     WHAT IS HAPPENING TO ME ?
YOUR PATIENT IS PASSING HARDLY ANY URINE

B.P. SYSTOLIC= 50  DIASTOLIC= 34  MEAN=  40.0
RIGHT ATRIAL PRESS.= -.3 MM HG  MEAN CAPILL.PRESS.=     3.9 MM HG
CARDIAC OUTPUT=  1.9 L/MIN, STROKE VOL.=  14.7 ML, HEART RATE= 132.
ART.RESIST.=  19.9   VENOUS RESIST.=  2.2 MM HG/L/MIN
CARDIAC CONTRACILITY=  1.1 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1..ART. RESISTANCE=  100.0 % OF NORMAL
2..VEN. RESISTANCE=  100.0 % OF NORMAL
3..CARDIAC CONTRACTILITY=  100.0 % OF NORMAL
4..MEAN INTRATHORACIC PRES.=  -2.0 MM HG
5..BLOOD VOLUME=  3000.0 ML
```

Figure B MACMAN has suddenly lost 2 litres of blood. His blood pressure has fallen and his heart is beating very rapidly.

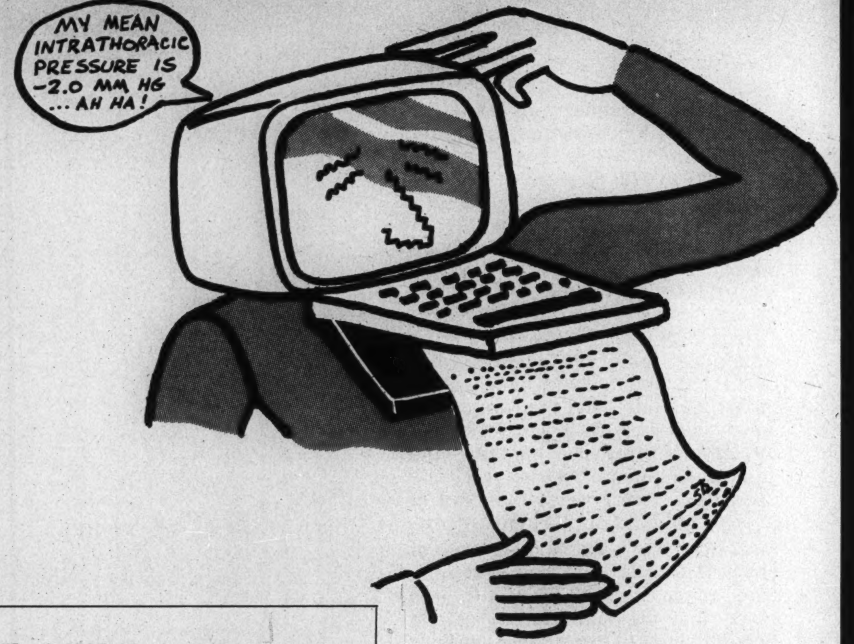
1. Arterial Resistance (expressed as percent of normal value) — is a measure of the pressure required to drive blood through the circulation channels in the body.
2. Venous Resistance (expressed as percent of normal value) — determines the return of blood to the heart.
3. Contractility (expressed as percent of normal value) describes the effectiveness of the heart as a pump.
4. Intra-thoracic pressure (mm of Mercury) is the pressure difference between the pressure inside the chest and the atmospheric pressure.
5. Blood volume is the total blood volume in the body in milli-litres.

MACMAN proved to be a great success and was quickly included in the medical curriculum at McMaster University, and later at many other medical schools around the world. This was easy because, unlike many physiological simulations, the **interface** between the user and the model has been accorded as much attention as the model itself. So anyone who can type with one finger can tinker with MACMAN's physiology. It also led Dr. Dickinson, and his associates in Can-

Medical, cont'd . . .

ada and England, to explore the possibilities of simulating other aspects of human physiology. A flurry of activity has followed at McMaster University and St. Bartholomew's Hospital in London. Four new models have evolved. They are far more complex and versatile than MACMAN and have been named MACPUF (simulation of lungs and respiration), MACPEE (simulation of — you guessed it — kidneys and body fluids), MACBABE (simulation of respiration in a pre-mature baby), and finally a very elegant model MACDOPE (simulation of drug distribution in the body), developed by a medical student Ralph Bloch (who is now a Professor at McMaster).

These simulation models have added a new dimension to medical education and research. Not only have they saved many animal experiments (and the associated pain and mess), but the students can now perform a virtually unlimited number of experiments, repeat them several times, try a different treatment each time (or withhold treatment and study the natural course of events). These models have been presented to a wide medical audience and are being used at over 70 different medical schools around the world. In fact, MACMAN and his cousins speak five different languages.


MY MEAN INTRATHORACIC PRESSURE IS -2.0 MM HG ... AH HA!

```
DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?1
..1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS
?1
TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED
?1
FACTOR  1 (CURRENTLY=  100.0 ), SPECIFY NEW VALUE
?200

DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?2

TIME 0  20  40  60  80  100 120 140 160 180 200 220 240 260 280 300
SECS .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  64               XXXXXX      *
  68               XXXXXX       *
  72               XXXXXX     *
  76              XXXXXXX   *
  80              XXXXXX    *
  84              XXXXXXX  *
  88              XXXXXX   *
  92              XXXXXX   *
  96              XXXXXX   *
 100              XXXXXXX *
 104              XXXXXXX *
 108              XXXXXXX *
 112               XXXXXX *
 116              XXXXXXX *
 120               XXXXXX *

   I AM VERY TIRED AND EXHAUSTED

   I DON'T FEEL LIKE DOING ANYTHING

   I FEEL BETTER BUT NOT RIGHT YET.
   CAN'T YOU DO SOMETHING FOR ME ?
YOUR PATIENT IS PASSING HARDLY ANY URINE

B.P. SYSTOLIC= 97  DIASTOLIC= 70  MEAN=  79.1
RIGHT ATRIAL PRESS.= -.5 MM HG  MEAN CAPILL.PRESS.=      4.1 MM HG
CARDIAC OUTPUT=  2.1 L/MIN, STROKE VOL.=  19.2 ML, HEART RATE= 110.
ART.RESIST.=  36.7   VENOUS RESIST.=  2.2 MM HG/L/MIN
CARDIAC CONTRACILITY=  1.4 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1..ART. RESISTANCE=  200.0 % OF NORMAL
2..VEN. RESISTANCE=  100.0 % OF NORMAL
3..CARDIAC CONTRACTILITY=  100.0 % OF NORMAL
4..MEAN INTRATHORACIC PRES.=  -2.0 MM HG
5..BLOOD VOLUME=  3000.0 ML
```

Figure C The effect of a drug to raise blood pressure is simulated. MACMAN has recovered somewhat, his symptoms have improved.

He is "not feeling too well" and "his eyes are going dim." If the simulation were allowed to continue for another three minutes, MACMAN would die and we would have a postmortem report.

The programs have all been written in standard Fortran and require interactive access to a suitable computer via ordinary (ASCII compatible) terminals. They have been implemented on a range of minicomputers and we plan to adapt them soon to microcomputers. A Basic version of MACMAN has also been developed. The other models have not been translated to Basic, owing to their complexity and high computation requirements.

Medical, cont'd . . .

```
DO YOU WANT TO  .1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?1
..1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS
?1
TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED
?5  1
FACTOR  5 (CURRENTLY= 3000.0 ), SPECIFY NEW VALUE
?4600
FACTOR  1 (CURRENTLY=  200.0 ), SPECIFY NEW VALUE
?100

DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?2

TIME 0  20  40  60  80  100 120 140 160 180 200 220 240 260 280 300
SECS .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
 124                  XXXX*XXXX
 128                 XXX*XXXXX
 132                XX*XXXXXX
 136                X*XXXXXX
 140               XX*XXXXXX
 144               XX*XXXXXX
 148               XX*XXXXXX
 152               XX*XXXXXX
 156               XX*XXXXXXX
 160               XX*XXXXXX
 164               XX*XXXXXX
 168               XX*XXXXXXX
 172               XX*XXXXXX
 176               XX*XXXXXX
 180               XX*XXXXX

   THAT'S BETTER DOCTOR.....
   BUT ARE YOU GOING TO DO ANY OTHER NASTY THINGS TO ME ?

B.P. SYSTOLIC=109  DIASTOLIC= 71  MEAN=  84.2
RIGHT ATRIAL PRESS.= 1.2 MM HG  MEAN CAPILL.PRESS.=     11.3 MM HG
CARDIAC OUTPUT=  4.6 L/MIN, STROKE VOL.=  55.6 ML, HEART RATE=  83.
ART.RESIST.=  16.6   VENOUS RESIST.=  2.2 MM HG/L/MIN
CARDIAC CONTRACILITY=  1.5 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1..ART. RESISTANCE=  100.0 % OF NORMAL
2..VEN. RESISTANCE=  100.0 % OF NORMAL
3..CARDIAC CONTRACTILITY=  100.0 % OF NORMAL
4..MEAN INTRATHORACIC PRES.=  -2.0 MM HG
5..BLOOD VOLUME=  4600.0 ML

DO YOU WANT TO  1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?4
```

Figure D MACMAN is now given some blood and the drug is removed. He is feeling much better.

The development of the MAC family has been a very rewarding experience to our group. It has provided us a much better understanding of the human systems and in some cases corrected our thinking. As always happens, designing these simulations has pointed out many grey areas in our knowledge. To the student and researcher, this tool is invaluable as it enables them to experiment and test hypotheses — there is no better way to learn than to perform critical experiments. This development opens yet another exciting possibility — the use of simulation in the clinic. We have already built features in the advanced models to allow the user to specify the age, sex, height and weight of the simulated subject. It is then possible by trial and error to "tune-in" a given patient, and then try different treatment plans. We have had some success in this area, though the procedure is fairly involved. We are currently working on making the models self-adjusting. Thus, one could enter the observed results (such as heart rate, blood pressure, levels of oxygen and carbon dioxide in blood, etc.) and let the model work out the other parameters to match the physical state of the actual patient. It would then be possible to predict the outcome of a treatment for a specific person more accurately. This could be a valuable tool for the future doctor and in the Intensive Care Unit.

We feel that computer simulation in medicine offers a lot of exciting possibilities and we are sure to witness new developments in the coming years — we have only begun to scratch the surface. Who knows, someday, you may dial up your 'family computer' about a problem in the middle of the night and out will come the answer "Take two aspirins and call me in the morning!" □

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Ecology: A Simulation Model for Small Populations of Animals.

James W. Grier

The impact of human activities on the populations of other species has been receiving increased interest and concern. The issue of the snail darter, a fish endangered by the proposed Tellico Dam, is probably the best known; but it is only one of numerous examples. Other cases involve the black-footed ferret, the timber wolf, some species of prairie chickens, the peregrine falcon, and many others; even our nation's symbol, the bald eagle.

Wildlife ecologists are developing new techniques for managing and attempting to save such species, by transplanting eggs, or young, or whole populations to different locations, or by breeding the species in captivity for reintroduction to the wild. Ecologists are also attempting to isolate and correct the most critical factors limiting the populations in the wild. A recent reference for work on birds is *Endangered Birds,* edited by S. A. Temple (Univ. of Wisc. Press, 1977).

One of the biggest problems in working with small populations, however, is the large part played by chance events — which can lead to several different outcomes. If one has only four animals — two females and two males, for example — and the expected mortality rate is 50 percent, the whole future of the population rests on *which* 50 percent dies. If by chance it is 1 female and 1 male, there is still a pair left which may reproduce and increase the population severalfold. If, however, the two females die, only the males remain and the population is doomed.

Chance can enter the picture at several points. Not only which individuals die, but how many young each female produces and the sex of those young, are chance determinations which affect the fate of the population.

The problem with most population models is that they are *deterministic,* that is, they are determined by a fixed set of values with no room for chance and with only one outcome. A classic example of such a model is the age-specific life table (for a reference, see C. J. Krebs. *Ecology.* Harper and Row, 1978. Chapter 10). These models may be useful for large populations, where the effects of chance can usually be ignored, but they simply are not realistic or useful for small populations. Most of the mathematical models that do allow for the variation caused by chance (called stochastic models) are either too simple to be realistic or too complex and restrictive to be of much use.

Monte Carlo Techniques and Basic's random function, RND, provided a solution to the problem. I first worked up a simple model that could be done by hand using the flipping of coins and a random numbers table. I used that for an ecology class laboratory exercise and gained enough experience with it to develop a larger, more complete computerized version. I developed the first computer program specifically for birds of prey (hawks, eagles, falcons and owls). It had two purposes: to stimulate and evaluate the probability of success of reintroducing peregrine falcons into the eastern United States, and to predict the fate of certain bald eagle populations, the species I have worked with mostly myself. The program had several options and permitted repeated simulations — something that a wildlife manager cannot do with the real thing. In real situations — wildlife transplants, reintroductions or the survival of a remnant population — there may be only one chance. In the computer the situation can be run hundreds or thousands of times to determine the likely range of outcomes.

One of the biggest problems in working with small populations is the large part played by chance events — which can lead to several different outcomes.

After completing that program I decided to modify it to be useful for a wider range of species. The initial program assumed monogamous breeding (one male, one female); but many species are polygamous, so I added an option for that. The termin-

---

James Grier, Zoology Dept., North Dakota State University, Fargo, ND 58102.

ology was changed to apply to all animals. The revised model still contains several more or less restrictive assumptions (Table 1), but it fits a large number of species and the program could be modified to make room for differences. The only real constraint in the model at present involves the number of young per female. The model gets increasingly awkward with increasing maximum numbers of young. Most species for which this model is intended produce only one to ten young at a time, and the program works fine. For species with larger numbers, the sections on reproduction (statements 620 to 730 and 2370 to 2640) could be modified. The flow chart is shown in Figure 1.

The revised program has now been used successfully in real applications, has become very popular for instructive purposes, and may even be used as a game. Life is most stimulating when one can mix work with pleasure, and this program has turned out to satisfy this ideal. By asking for information which often is not known, it points out and emphasizes the need for further research. In the meantime, and to better understand the model and what might happen under various situations, one can easily provide hypothetical values.

The program had several options and permitted repeated simulations — something that a wildlife manager cannot do with the real thing.

The program and some sample runs are provided here. The program contains about 300 statements and 10,000 characters. If that is too much for a user's available memory, it can be greatly shortened by separating out the comments and by eliminating some of the options, such as those that permit automatic repetition. I also have written 1) a companion deterministic program that shows what happens, in a similar format, when chance is removed and 2) a program (oriented toward birds) for life tables. Both of those programs are free from me on request. □

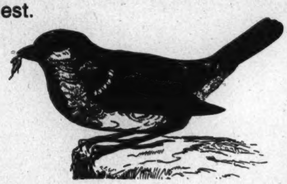
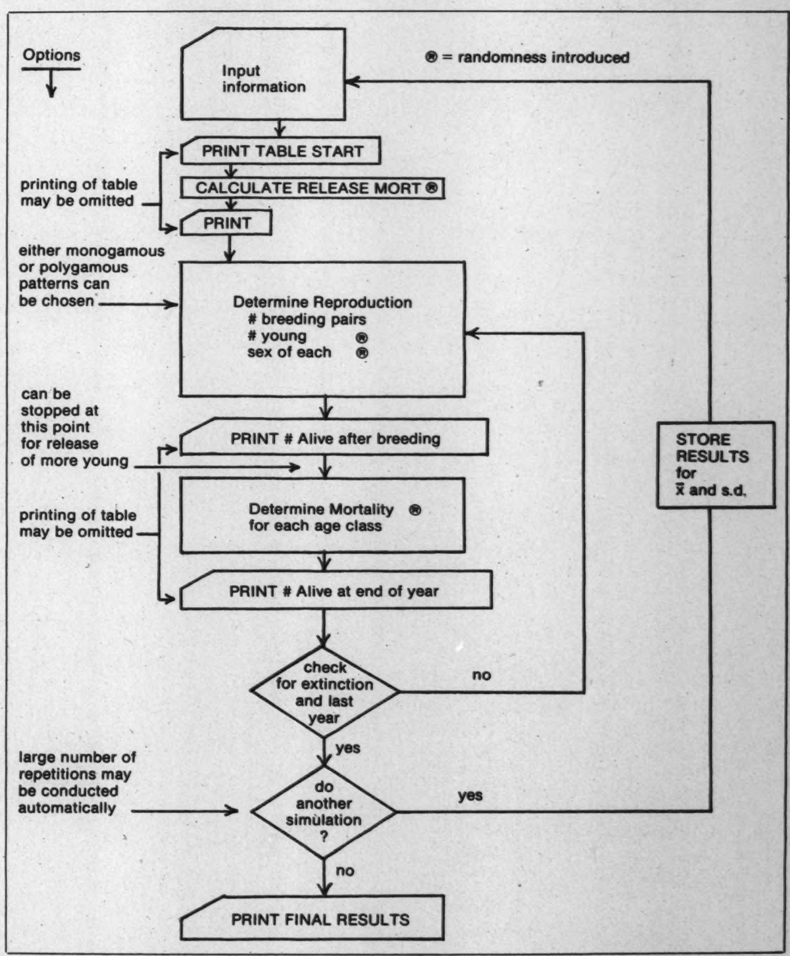


Table 1. Assumptions of the Population Model.

1) Breeding is seasonal and more or less synchronized in the population so that all birth or hatching occurs within a relatively short period.
2) If monogamous breeding is chosen, the number of breeding pairs is limited by the sex with the least number of adults; otherwise it is limited by the number of adult females, assuming that at least one male is present.
3) Members of potential pairs can find each other for purposes of breeding and are behaviorally/physiologically capable of breeding.
4) There are no inbreeding problems.
5) No density-dependent effects limit the population growth (although computer time might).
6) All of the mortality occurs outside the reproductive season. (And only those young that fledge or are weaned are counted in the first place. This eliminates those that die in the uterus, nest, etc. and permits the assumption to be fairly reasonable.)
7) Male and female mortality rates are the same.
8) Mortality rates are constant (within the random limits) for animals over one year of age. This assumes that the animals do not reach senility, and die from physiological old age in the wild.
9) The mortality and reproductive rates do not change significantly over time, that is, during the years of simulation.


Options
® = randomness introduced
Input information
PRINT TABLE START
printing of table may be omitted
CALCULATE RELEASE MORT ®
PRINT
either monogamous or polygamous patterns can be chosen
Determine Reproduction
# breeding pairs
# young ®
sex of each ®
can be stopped at this point for release of more young
PRINT # Alive after breeding
printing of table may be omitted
Determine Mortality ® for each age class
PRINT # Alive at end of year
STORE RESULTS for x̄ and s.d.
check for extinction and last year
no
yes
large number of repetitions may be conducted automatically
do another simulation ?
yes
no
PRINT FINAL RESULTS

```
END OF THIS SIMULATION. YOUR FINAL POPULATION
IS 2    PEREGRINE FALCON(S).

TABLE 3    PEREGRINE FALCONS ALIVE FOR EACH YEAR OF SIMULATION.

        FIRST    FIRST    SUBAD.   SUBAD.   ADULT    ADULT    TOTAL
        YEAR     YEAR
YEAR    MALES    FEMALES  MALES    FEMALES  MALES    FEMALES  ALIVE
------------------------------------------------------------------------
  0        6        6        0        0        0        0       12
           0        1        0        0        0        0        1

  1        0        0        0        1        0        0        1
           0        0        0        1        0        0        1

  2        0        0        0        1        0        0        1
           0        0        0        0        0        0        0

------------------------------------------------------------------------
THIS POPULATION OF PEREGRINE FALCONS DID NOT SURVIVE!

YOU RAN  3    SIMULATIONS.
THE MEAN FINAL POPULATION OF PEREGRINE FALCONS
(FOR SUCCESSFUL CASES) IS 1.5
WITH A STANDARD DEVIATION OF  .7    .
THERE WERE(WAS) 1    SIMULATION(S) THAT WENT TO EXTINCTION.

SEE YA.
TIME 4.6 SECS



RUN
7 SPG 10/22/79 13:54:31

   *** A STOCHASTIC MODEL FOR SMALL POPULATIONS ***

                BY JAMES W. GRIER
        ZOOLOGY DEPT., NDSU, FARGO ND 58105


DO YOU WANT INTRODUCTORY COMMENTS (1=YES, 2=NO)?
2
DO YOU WANT THE SIMULATION AUTOMATICALLY
REPEATED MORE THAN ONCE (1=YES, 2=NO)?
1
HOW MANY TIMES DO YOU WANT THE SIMULATION REPEATED?
100
(NOTE: IF THE PROGRAM STOPS ANYTIME BECAUSE YOU EXCEEDED
THE CPU LIMIT, HIT RETURN AND IT WILL RESUME.)
CHOOSE NOW WHETHER OR NOT TO HAVE THE TABLE PRINTED (1=YES,
PRINT THE TABLE; 2=NO, DO NOT PRINT THE TABLE AT ALL).?
2


WHAT SPECIES ARE YOU WORKING WITH?
PEREGRINE FALCON
DOES THIS SPECIES NORMALLY HAVE MONOGAMOUS (=M) OR
POLYGAMOUS (=P) BREEDING PATTERNS?
M
AT WHAT AGE DO YOU BELIEVE THE PEREGRINE FALCONS
NORMALLY BEGIN BREEDING?
3
WHAT IS THE MAXIMUM NUMBER OF YOUNG PER BREEDING FEMALE?
4
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 0    YOUNG?
20
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 1    YOUNG?
10
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 2    YOUNG?
30
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 3    YOUNG?
30
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 4    YOUNG?
10
WHAT IS THE ESTIMATED FIRST YEAR MORTALITY RATE
FOR PEREGRINE FALCONS?
60
WHAT IS YOUR GUESS FOR THE ANNUAL MORTALITY
RATE OF OLDER PEREGRINE FALCONS?
25
HOW MANY YEARS DO YOU WANT THE SIMULATION TO RUN?
5
HOW MANY MALE AND FEMALE OF THE YEAR ARE YOU
RELEASING (SPECIFY BOTH. SEPARATE WITH COMMA.)?
6,6
DO YOU PLAN TO RELEASE ANY OLDER PEREGRINE FALCONS (1=YES, 2=NO)?
2
WOULD YOU LIKE THE OPTION OF RELEASING ADDITIONAL YOUNG IN
SUBSEQUENT YEARS, AFTER THE SIMULATION HAS STARTED (1=YES,2=NO)
NOTE: DO NOT CHOOSE THIS OPTION IF THE SIMULATION IS BEING
     AUTOMATICALLY REPEATED MORE THAN 5 TIMES.

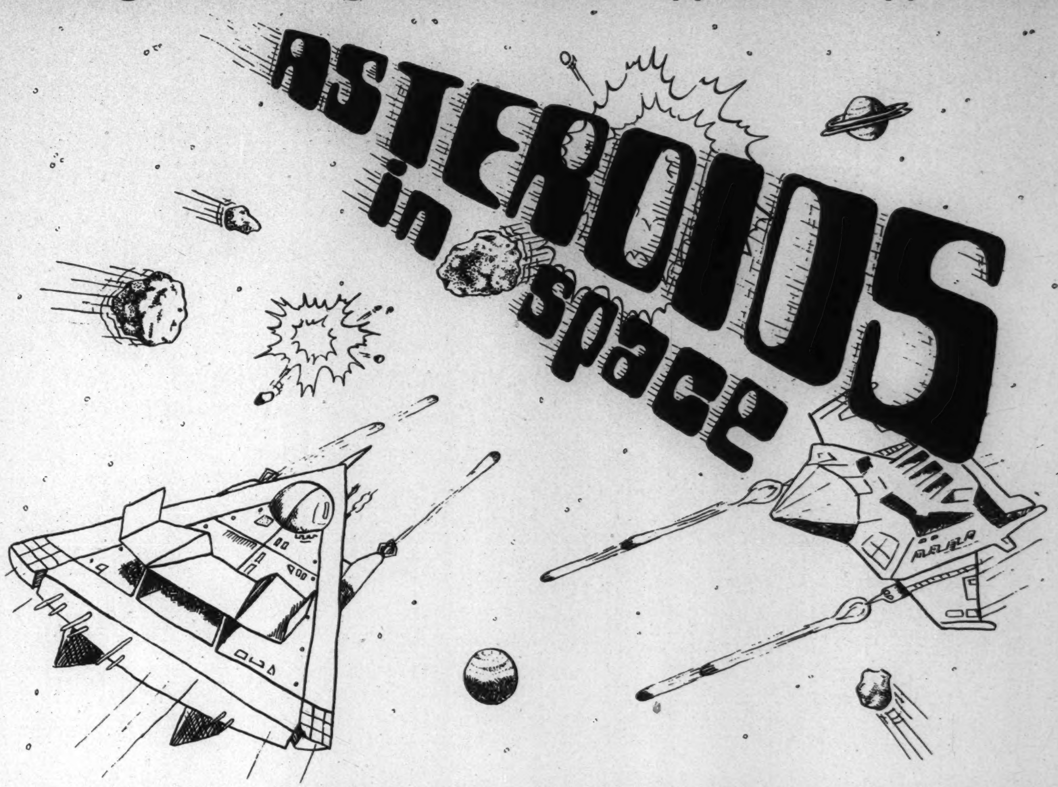
?
2

YOU RAN  100  SIMULATIONS.
THE MEAN FINAL POPULATION OF PEREGRINE FALCONS
(FOR SUCCESSFUL CASES) IS 2.639999
WITH A STANDARD DEVIATION OF  1.75    .
THERE WERE(WAS) 22   SIMULATION(S) THAT WENT TO EXTINCTION.
THIS GIVES AN ESTIMATED PROBABILITY OF EXTINCTION OF .22
OR THE CHANCE OF SUCCESS BEING .78  .

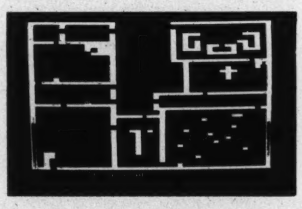
SEE YA.
TIME 7.0 SECS
```

```
 10 PRINT
 20 PRINT "  *** A STOCHASTIC MODEL FOR SMALL POPULATIONS ***"
 30 PRINT
 40 PRINT "                 BY JAMES W. GRIER"
 50 PRINT "         ZOOLOGY DEPT., NDSU, FARGO ND 58105"
 60 PRINT
 70 PRINT
 80 PRINT "DO YOU WANT INTRODUCTORY COMMENTS (1=YES, 2=NO)";
 90 INPUT A6
100 IF A6=2 THEN 290
110 PRINT "     CHANCE EVENTS ARE IMPORTANT FACTORS IN THE GROWTH PATTERNS"
120 PRINT "OF ANIMAL POPULATIONS, PARTICULARLY SMALL POPULATIONS.  THIS"
130 PRINT "PROGRAM INCORPORATES CHANCE FOR BROOD OR LITTER SIZE, SEX OF"
140 PRINT "EACH INDIVIDUAL BORN OR HATCHED, AND MORTALITY -- AT PROBABILITIES"
150 PRINT "FOR REPRODUCTION AND MORTALITY THAT YOU SUPPLY. (PROBABILITY"
160 PRINT "FOR SEX RATIO IS ASSUMED TO BE 50:50.)"
170 PRINT
180 PRINT "     THE PROGRAM IS BOTH GENERAL AND FLEXIBLE, PERMITTING"
190 PRINT "SEVERAL OPTIONS OR CHOICES. ONE OPTION ALLOWS THE SIMULATION TO BE"
200 PRINT "REPEATED MORE THAN ONCE AUTOMATICALLY.  DEPENDING ON THE SIZE OF"
210 PRINT "THE POPULATION, LENGTH OF SIMULATION, AND OTHER CHARACTERISTICS"
220 PRINT "OF THE SET OF PARAMETERS THAT YOU USE, HOWEVER, THE SIMULATION"
230 PRINT "MAY REQUIRE A LOT OF COMPUTER TIME AND A LARGE NUMBER OF"
240 PRINT "REPETITIONS COULD USE AN EXCESSIVE AMOUNT OF COMPUTER TIME."
250 PRINT "THEREFORE, YOU SHOULD NOT CHOOSE TO USE THIS OPTION UNTIL AFTER"
260 PRINT "YOU HAVE RUN A SIMILAR SIMULATION AT LEAST ONCE, CHECKED THE"
270 PRINT "TIME IT TOOK AND ESTIMATED THE TIME REQUIREMENTS FOR SEVERAL"
280 PRINT "REPETITIONS."
290 PRINT "DO YOU WANT THE SIMULATION AUTOMATICALLY"
300 PRINT "REPEATED MORE THAN ONCE (1=YES, 2=NO)";
310 C=0
320 INPUT A0
330 IF A0=2 THEN 360
340 PRINT "HOW MANY TIMES DO YOU WANT THE SIMULATION REPEATED";
350 INPUT C
355 PRINT "(NOTE: IF THE PROGRAM STOPS ANYTIME BECAUSE YOU EXCEEDED"
356 PRINT "THE CPU LIMIT, HIT RETURN AND IT WILL RESUME.)"
360 IF A6=2 THEN 480
370 PRINT
371 PRINT "     THE INPUT IS REQUESTED FROM THE CONTEXT OF A POPULATION"
372 PRINT "BEING ARTIFICIALLY INTRODUCED TO AN AREA, AS IN THE INTRODUCTION"
373 PRINT "OF AN EXOTIC SPECIES OR THE REINTRODUCTION OR TRANSPLANTING OF"
374 PRINT "AN ENDANGERED SPECIES.  THE PROGRAM CAN ALSO BE USED, HOWEVER,"
375 PRINT "TO MODEL EXISTING NATURAL POPULATIONS.  WHEN THE PROGRAM REQUESTS"
376 PRINT 'INFORMATION ON ANIMALS BEING "RELEASED," SIMPLY THINK IN TERMS'
377 PRINT 'OF ANIMALS THAT "ARE PRESENT."'
378 PRINT
380 PRINT "     NEXT, AN EXPLANATION OF THE RESULTS:  THE OUTCOME IS"
390 PRINT "TABULATED ON A YEAR BY YEAR BASIS. THERE ARE TWO LINES PRINTED"
400 PRINT "FOR EACH YEAR, THE FIRST IS THE NUMBER OF ANIMALS ALIVE AT THE"
410 PRINT "END OF THE REPRODUCTIVE SEASON. THE SECOND IS THE NUMBER ALIVE"
420 PRINT "AT THE END OF THE YEAR, AFTER MORTALITY HAS OCCURRED AND PRIOR"
430 PRINT "TO THE NEXT REPRODUCTIVE SEASON. THE FINAL OUTCOME IS STORED"
440 PRINT "AND AVERAGED OVER SUCCESSIVE SIMULATIONS, IF THERE ARE MORE"
450 PRINT "THAN ONE. IN CASE THE SIMULATION IS REPEATED MORE THAN FIVE "
460 PRINT "TIMES, THE YEARLY TABLE IS PRINTED ONLY THE FIRST FIVE TIMES."
470 PRINT "UNLESS YOU DO NOT WANT THE TABLE PRINTED AT ALL.  YOU NEED TO"
480 PRINT "CHOOSE NOW WHETHER OR NOT TO HAVE THE TABLE PRINTED (1=YES,"
490 PRINT "PRINT THE TABLE; 2=NO, DO NOT PRINT THE TABLE AT ALL).";
500 INPUT A2
510 IF A6=2 THEN 580
520 PRINT
530 PRINT "     A FINAL NOTE BEFORE STARTING:  THE MODEL NECESSARILY"
540 PRINT "CONTAINS SEVERAL MATHEMATICAL AND BIOLOGICAL ASSUMPTIONS BUT"
550 PRINT "IT WOULD TAKE TOO MUCH SPACE TO LIST THEM ALL HERE. IF YOU"
560 PRINT "WANT A LIST OF THESE OR ANY ADDITIONAL DOCUMENTATION, OR TO"
570 PRINT "REPORT ANY BUGS, PLEASE CONTACT J. W. GRIER."
580 PRINT
590 PRINT
600 PRINT "WHAT SPECIES ARE YOU WORKING WITH";
610 INPUT S$
620 PRINT "DOES THIS SPECIES NORMALLY HAVE MONOGAMOUS (=M) OR"
630 PRINT "POLYGAMOUS (=P) BREEDING PATTERNS";
640 INPUT B$
650 PRINT "AT WHAT AGE DO YOU BELIEVE THE "; S$; "S"
660 PRINT "NORMALLY BEGIN BREEDING";
```

Exciting, entertaining software for the Apple II and Apple II Plus*

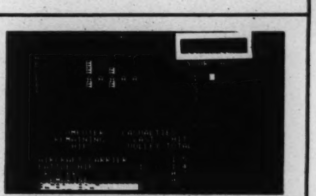


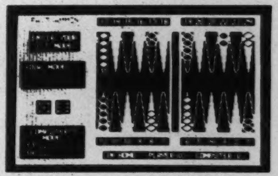
If you liked "Invaders", you'll love ASTEROIDS IN SPACE by Bruce Wallace. Your space ship is traveling in the middle of a shower of asteroids. Blast the asteroids with lasers, but beware — big asteroids fragment into small asteroids! The Apple game paddles allow you to rotate your space ship, fire its laser gun, and give it thrust to propel it through endless space. From time to time you will encounter an alien space ship whose mission is to destroy you, so you'd better destroy it first! High resolution graphics and sound effects add to the arcade-like excitement that this program generates. Runs on any Apple II with at least 32K and one disk drive.
On diskette — **$19.95**



FRACAS™ by Stuart Smith. A fantastic adventure game like no other — up to eight players can participate in FRACAS at the same time. Journey in the land of FAROPH, searching for hidden treasure while warding off all sorts of unfriendly and dangerous creatures like the Ten Foot Spider and the Headless Horseman. You and your friends can compete with each other or you can join forces and gang up on the monsters. Your location is presented graphically and sound effects enliven the battles. Save your adventure on diskette or cassette and continue it at some other time. Requires at least 32K of RAM. Cassette: **$19.95** Diskette: **$24.95**

BATTLESHIP COMMANDER™ by Erik Kilk and Matthew Jew. A game of strategy. You and the computer each start out by positioning five ships of different sizes on a ten by ten grid. Then the shooting starts. Place your volleys skillfully — a combination of logic and luck are required to beat the computer. Cartoons show the ships sinking and announce the winner. Sound effects and flashing lights also add to the enjoyment of the game. Requires at least 32K of RAM.
Cassette: **$14.95** Diskette: **$24.95**





FASTGAMMON™ by Bob Christiansen. Sound, hi res color, and cartoons have helped maked this the most popular backgammon-playing game for the Apple II. But don't let these entertaining features fool you — FASTGAMMON plays serious backgammon. Requires at least 24K of RAM.
Cassette: **$19.95** Diskette: **$24.95**

QS QUALITY SOFTWARE

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CIRCLE 178 ON READER SERVICE CARD

Ecology, cont'd...

```
670 INPUT A
680 PRINT "WHAT IS THE MAXIMUM NUMBER OF YOUNG PER BREEDING FEMALE";
690 INPUT B
700 FOR L=0 TO B
710 PRINT "WHAT PERCENT OF THE ADULT FEMALES PRODUCE";L;"YOUNG";
720 INPUT B(L+1)
730 NEXT L
740 PRINT "WHAT IS THE ESTIMATED FIRST YEAR MORTALITY RATE"
750 PRINT "FOR "; S$;"S";
760 INPUT I
770 PRINT "WHAT IS YOUR GUESS FOR THE ANNUAL MORTALITY"
780 PRINT "RATE OF OLDER ";S$;"S";
790 INPUT H
800 LET S=0
810 LET S2=0
820 LET G=0
830 LET R=0
840 PRINT "HOW MANY YEARS DO YOU WANT THE SIMULATION TO RUN";
850 INPUT N
860 DIM M(35), F(35)
870 DIM E(35), J(35)
880 MAT M=ZER(35)
890 MAT F=ZER(35)
900 MAT E=ZER(35)
910 MAT J=ZER(35)
920 IF A=1 THEN 1010
930 PRINT "HOW MANY MALE AND FEMALE OF THE YEAR ARE YOU"
940 PRINT "RELEASING (SPECIFY BOTH, SEPARATE WITH COMMA.)";
950 INPUT E(A),J(A)
960 LET U(1)=0
970 LET U(2)=0
980 PRINT "DO YOU PLAN TO RELEASE ANY OLDER ";S$;"S (1=YES, 2=NO)";
990 INPUT A3
1000 IF A3=2 THEN 1100
1010 FOR X = 1 TO A-2
1020 PRINT "HOW MANY MALES AND FEMALES ";X;"YEAR(S) OLD";
1030 INPUT E(A-X),J(A-X)
1040 LET U(1)=U(1)+E(A-X)
1050 LET U(2)=U(2)+J(A-X)
1060 NEXT X
1070 PRINT "HOW MANY MALES AND FEMALES";" ";A-1;" YEARS"
1080 PRINT "OR OLDER (POTENTIAL BREEDERS FOR THE NEXT SEASON) ARE YOU RELEASING";
1090 INPUT E(1),J(1)
1100 PRINT "WOULD YOU LIKE THE OPTION OF RELEASING ADDITIONAL YOUNG IN"
1110 PRINT "SUBSEQUENT YEARS, AFTER THE SIMULATION HAS STARTED (1=YES,2=NO)"
1120 PRINT "NOTE: DO NOT CHOOSE THIS OPTION IF THE SIMULATION IS BEING"
1130 PRINT "      AUTOMATICALLY REPEATED MORE THAN 5 TIMES."
1140 INPUT A1
1150 IF A1=2 THEN 1200
1160 PRINT "AFTER THE REPRODUCTION FOR THE ANIMALS IN THE WILD HAS BEEN"
1170 PRINT "DETERMINED, THE SIMULATION WILL STOP. AFTER THE QUESTION MARK"
1180 PRINT "APPEARS, ENTER THE NUMBER OF MALE, FEMALE YOUNG OF THE YEAR THAT"
1190 PRINT "YOU WISH TO ADD FOR THAT YEAR."
1200 MAT M=E
1210 MAT F=J
1220 LET D(1)=0
1230 LET D(2)=0
1240 MAT D=U
1250 LET D(1)=D(1)+M(1)
1260 LET D(2)=D(2)+F(1)
1270 IF R>4 THEN 1320
1280 IF A2=2 THEN 1320
1290 PRINT
1300 PRINT "TABLE";R+1;S$;"S ALIVE FOR EACH YEAR OF SIMULATION."
1310 PRINT
1320 LET W=0
1330 LET O(1)=0
1340 LET O(2)=0
1350 LET Y=A
1360 IF R>4 THEN 1430
1370 IF A2=2 THEN 1430
1380 :####     #######  #######  #######  #######  #######  #######  #######
1390 PRINT USING 1380," ","FIRST","FIRST","SUBAD.","SUBAD.","ADULT","ADULT","TOTAL"
1400 PRINT USING 1380," ","YEAR","YEAR"," "," "," "," "," "
1410 PRINT USING 1380,"YEAR","MALES","FEMALES","MALES","FEMALES","MALES","FEMALES", "ALIVE"
1420 PRINT "----------------------------------------------------------------------"
1430 IF W=0 THEN 2750
1440 LET P=M(Y)
1450 IF P=0 THEN 1500
1460 FOR Q=1 TO P
1470 IF INT(100*RND)>=I THEN 1490
1480 LET M(Y)=M(Y)-1
1490 NEXT Q
1500 LET P=F(Y)
1510 IF P=0 THEN 1560
1520 FOR Q=1 TO P
1530 IF INT(100*RND)>=I THEN 1550
1540 LET F(Y)=F(Y)-1
1550 NEXT Q
1560 FOR Z=Y-1 TO 1 STEP -1
1570 LET P=M(Z)
1580 IF P=0 THEN 1630
1590 FOR  Q=1 TO P
1600 IF INT(100*RND)>=H THEN 1620
1610 LET M(Z)=M(Z)-1
1620 NEXT Q
1630 LET P =F(Z)
1640 IF P=0 THEN 1690
1650 FOR Q=1 TO P
1660 IF INT(100*RND)>=H THEN 1680
1670 LET F(Z)=F(Z)-1
1680 NEXT Q
1690 NEXT Z
1700 GOSUB 1720
1710 GO TO 1900
1720 LET D(1)=0
1730 FOR L=Y-A+1 TO Y-1
1740 LET D(1)=D(1) + M(L)
1750 NEXT L
1760 LET D(2)=0
1770 FOR L=Y-A+1 TO Y-1
1780 LET D(2)=D(2)+F(L)
1790 NEXT L
1800 LET O(1)=0
1810 FOR L=1 TO Y-A
1820 LET O(1) =O(1) +M(L)
1830 NEXT L
1840 LET O(2)=0
1850 FOR L=1 TO Y-A
1860 LET O(2) = O(2) + F(L)
1870 NEXT L
1880 LET T=M(Y)+F(Y)+D(1)+D(2)+O(1)+O(2)
1890 RETURN
1900 IF R>4 THEN 1940
1910 IF A2=2 THEN 1940
1920 PRINT USING 1380," ",M(Y),F(Y),D(1),D(2),O(1),O(2),M(Y)+F(Y)+D(1)+D(2)+O(1)+O(2)
1930 PRINT
1940 IF T<>0 THEN 2010
1950 LET G=G+1
1960 IF R>4 THEN 2000
1970 IF A2=2 THEN 2000
1980 PRINT "----------------------------------------------------------------------"
1990 PRINT "THIS POPULATION OF ";S$;"S DID NOT SURVIVE "
2000 GO TO 2070
2010 IF W<=N THEN 2350
2020 IF R>4 THEN 2070
2030 IF A2=2 THEN 2070
2040 PRINT "----------------------------------------------------------------------"
2050 PRINT "END OF THIS SIMULATION. YOUR FINAL POPULATION"
2060 PRINT "IS";T;S$;"(S)."
2070 LET R=R+1
2080 LET S=S+T
2090 LET S2=S2+T*T
2100 IF C=0 THEN 2130
2110 IF R<C THEN 1200
2120 IF C>0 THEN 2160
2130 PRINT "WOULD YOU LIKE TO RUN ANOTHER SIMULATION (1=YES, 2=NO)";
2140 INPUT A4
2150 IF A4=1 THEN 2300
2160 GO TO 2200
2170 PRINT
2180 PRINT "SEE YA."
2190 STOP
2200 IF R=1 THEN 2170
2210 PRINT
2220 PRINT "YOU RAN ";R;"SIMULATIONS."
2222 IF (R-G)=0 THEN 2250
2223 IF ((R-G)-1)=0 THEN 2250
2225 PRINT "THE MEAN FINAL POPULATION OF ";S$;"S"
2230 PRINT "(FOR SUCCESSFUL CASES) IS";INT(100*S/(R-G))/100
2240 PRINT "WITH A STANDARD DEVIATION OF ";INT(100*SQR(((R-G)*S2-S*S)/(R-G)/((R-G)-1)))/100;"."
2250 PRINT "THERE WERE(WAS)";G;"SIMULATION(S) THAT WENT TO EXTINCTION."
2260 IF R<20 THEN 2290
2270 PRINT "THIS GIVES AN ESTIMATED PROBABILITY OF EXTINCTION OF";INT(100*G/R)/100
2280 PRINT "OR THE CHANCE OF SUCCESS BEING";1-(INT(100*G/R)/100);"."
2290 GO TO 2170
2300 PRINT "WOULD YOU LIKE TO HAVE THE NEXT SIMULATION RUN UNDER"
2310 PRINT "THE SAME CONDITIONS AS THE LAST TIME (1=YES, 2=NO)";
2320 INPUT A5
2330 IF A5=2 THEN 600
2340 GO TO 1200
2350 LET Y=Y+1
2360 GOSUB 1720
2370 LET K=0
2380 IF B$="M" THEN 2410
2390 IF O(1)=0 THEN 2650
2400 GO TO 2420
2410 IF O(1)<O(2) THEN 2550
2420 FOR J=1 TO O(2)
2430 GO SUB 2450
2440 GO TO 2520
2450 LET P=INT((B+1)*RND)
2460 FOR L=0 TO B
2470 IF P<>L THEN 2500
2480 IF INT(100*RND)>=(B(L+1)) THEN 2450
2490 LET K=K+P
2500 NEXT L
2510 RETURN
2520 NEXT J
2530 IF B$="P" THEN 2590
2540 GO TO 2590
2550 FOR J=1 TO O(1)
2560 GO SUB 2450
2570 GO TO 2580
2580 NEXT J
2590 FOR L=1 TO K
2600 IF INT(2*RND)=0 THEN 2630
2610 LET M(Y)=M(Y) + 1
2620 GO TO 2640
2630 LET F(Y)=F(Y)+1
2640 NEXT L
2650 IF R>4 THEN 2680
2660 IF A2=2 THEN 2680
2670 PRINT USING 1380,W,M(Y),F(Y),D(1),D(2),O(1),O(2),M(Y)+F(Y)+D(1)+D(2)+O(1)+O(2)
2680 LET W=W+1
2690 IF A1<>1 THEN 1440
2700 IF W=1 THEN 1440
2710 INPUT U,V
2720 LET M(Y)=M(Y)+U
2730 LET F(Y)=F(Y)+V
2740 GO TO 1440
2750 IF A=1 THEN 2770
2760 GO TO 2650
2770 IF R>4 THEN 2680
2780 IF A2=2 THEN 2680
2790 PRINT USING 1380, W,M(Y),F(Y),0,0,0,0,M(Y)+F(Y)
2800 GO TO 2680
2810 END
```

```
RUN
7 SPG 10/22/79 13:48:14

  *** A STOCHASTIC MODEL FOR SMALL POPULATIONS ***

              BY JAMES W. GRIER
       ZOOLOGY DEPT., NDSU, FARGO ND 58105


DO YOU WANT INTRODUCTORY COMMENTS (1=YES, 2=NO)?
1
     CHANCE EVENTS ARE IMPORTANT FACTORS IN THE GROWTH PATTERNS
OF ANIMAL POPULATIONS, PARTICULARLY SMALL POPULATIONS.  THIS
PROGRAM INCORPORATES CHANCE FOR BROOD OR LITTER SIZE, SEX OF
EACH INDIVIDUAL BORN OR HATCHED, AND MORTALITY -- AT PROBABILITIES
FOR REPRODUCTION AND MORTALITY THAT YOU SUPPLY. (PROBABILITY
FOR SEX RATIO IS ASSUMED TO BE 50:50.)

     THE PROGRAM IS BOTH GENERAL AND FLEXIBLE, PERMITTING
SEVERAL OPTIONS OR CHOICES. ONE OPTION ALLOWS THE SIMULATION TO BE
REPEATED MORE THAN ONCE AUTOMATICALLY.  DEPENDING ON THE SIZE OF
THE POPULATION, LENGTH OF SIMULATION, AND OTHER CHARACTERISTICS
OF THE SET OF PARAMETERS THAT YOU USE. HOWEVER, THE SIMULATION
MAY REQUIRE A LOT OF COMPUTER TIME AND A LARGE NUMBER OF
REPETITIONS COULD USE AN EXCESSIVE AMOUNT OF COMPUTER TIME.
THEREFORE, YOU SHOULD NOT CHOOSE TO USE THIS OPTION UNTIL AFTER
YOU HAVE RUN A SIMILAR SIMULATION AT LEAST ONCE, CHECKED THE
TIME IT TOOK AND ESTIMATED THE TIME REQUIREMENTS FOR SEVERAL
REPETITIONS.
uO YOU WANT THE SIMULATION AUTOMATICALLY
REPEATED MORE THAN ONCE (1=YES, 2=NO)?
1
HOW MANY TIMES DO YOU WANT THE SIMULATION REPEATED?
3
(NOTE: IF THE PROGRAM STOPS ANYTIME BECAUSE YOU EXCEEDED
THE CPU LIMIT, HIT RETURN AND IT WILL RESUME.)

     THE INPUT IS REQUESTED FROM THE CONTEXT OF A POPULATION
BEING ARTIFICIALLY INTRODUCED TO AN AREA, AS IN THE INTRODUCTION
OF AN EXOTIC SPECIES OR THE REINTRODUCTION OR TRANSPLANTING OF
AN ENDANGERED SPECIES.  THE PROGRAM CAN ALSO BE USED, HOWEVER,
iO MODEL EXISTING NATURAL POPULATIONS.  WHEN THE PROGRAM REQUESTS
INFORMATION ON ANIMALS BEING 'RELEASED,' SIMPLY THINK IN TERMS
OF ANIMALS THAT 'ARE PRESENT.'

     NEXT, AN EXPLANATION OF THE RESULTS:  THE OUTCOME IS
TABULATED ON A YEAR BY YEAR BASIS. THERE ARE TWO LINES PRINTED
FOR EACH YEAR, THE FIRST IS THE NUMBER OF ANIMALS ALIVE AT THE
END OF THE REPRODUCTIVE SEASON. THE SECOND IS THE NUMBER ALIVE
AT THE END OF THE YEAR, AFTER MORTALITY HAS OCCURRED AND PRIOR
TO THE NEXT REPRODUCTIVE SEASON. THE FINAL OUTCOME IS STORED
AND AVERAGED OVER SUCCESSIVE SIMULATIONS, IF THERE ARE MORE
THAN ONE. IN CASE THE SIMULATION IS REPEATED MORE THAN FIVE
TIMES, THE YEARLY TABLE IS PRINTED ONLY THE FIRST FIVE TIMES,
UNLESS YOU DO NOT WANT THE TABLE PRINTED AT ALL.  YOU NEED TO
CHOOSE NOW WHETHER OR NOT TO HAVE THE TABLE PRINTED (1=YES,
PRINT THE TABLE; 2=NO, DO NOT PRINT THE TABLE AT ALL).?
1

     A FINAL NOTE BEFORE STARTING:  THE MODEL NECESSARILY
CONTAINS SEVERAL MATHEMATICAL AND BIOLOGICAL ASSUMPTIONS BUT
IT WOULD TAKE TOO MUCH SPACE TO LIST THEM ALL HERE. IF YOU
WANT A LIST OF THESE OR ANY ADDITIONAL DOCUMENTATION, OR TO
REPORT ANY BUGS, PLEASE CONTACT J. W. GRIER.


WHAT SPECIES ARE YOU WORKING WITH?
PEREGRINE FALCON
DOES THIS SPECIES NORMALLY HAVE MONOGAMOUS (=M) OR
POLYGAMOUS (=P) BREEDING PATTERNS?
M
AT WHAT AGE DO YOU BELIEVE THE PEREGRINE FALCONS
NORMALLY BEGIN BREEDING?
3
WHAT IS THE MAXIMUM NUMBER OF YOUNG PER BREEDING FEMALE?
4
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 0    YOUNG?
20
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 1    YOUNG?
10
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 2    YOUNG?
30
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 3    YOUNG?
30
WHAT PERCENT OF THE ADULT FEMALES PRODUCE 4    YOUNG?
10
WHAT IS THE ESTIMATED FIRST YEAR MORTALITY RATE
FOR PEREGRINE FALCONS?
60
WHAT IS YOUR GUESS FOR THE ANNUAL MORTALITY
RATE OF OLDER PEREGRINE FALCONS?
25
HOW MANY YEARS DO YOU WANT THE SIMULATION TO RUN?
5
HOW MANY MALE AND FEMALE OF THE YEAR ARE YOU
RELEASING (SPECIFY BOTH, SEPARATE WITH COMMA.)?
6,6
DO YOU PLAN TO RELEASE ANY OLDER PEREGRINE FALCONS (1=YES, 2=NO)?

2
WOULD YOU LIKE THE OPTION OF RELEASING ADDITIONAL YOUNG IN
SUBSEQUENT YEARS, AFTER THE SIMULATION HAS STARTED (1=YES,2=NO)
NOTE: DO NOT CHOOSE THIS OPTION IF THE SIMULATION IS BEING
      AUTOMATICALLY REPEATED MORE THAN 5 TIMES.
?
2

TABLE 1    PEREGRINE FALCONS ALIVE FOR EACH YEAR OF SIMULATION.

        FIRST    FIRST    SUBAD.   SUBAD.   ADULT    ADULT    TOTAL
        YEAR     YEAR
YEAR    MALES    FEMALES  MALES    FEMALES  MALES    FEMALES  ALIVE
---------------------------------------------------------------------
  0         6        6       0        0        0        0      12
            1        3       0        0        0        0       4

  1         0        0       1        3        0        0       4
            0        0       0        3        0        0       3

  2         0        0       0        3        0        0       3
            0        0       0        3        0        0       3

  3         0        0       0        0        0        3       3
            0        0       0        0        0        1       1

  4         0        0       0        0        0        1       1
            0        0       0        0        0        1       1

  5         0        0       0        0        0        1       1
            0        0       0        0        0        1       1

---------------------------------------------------------------------
END OF THIS SIMULATION. YOUR FINAL POPULATION
IS 1    PEREGRINE FALCON(S).

TABLE 2    PEREGRINE FALCONS ALIVE FOR EACH YEAR OF SIMULATION.

        FIRST    FIRST    SUBAD.   SUBAD.   ADULT    ADULT    TOTAL
        YEAR     YEAR
YEAR    MALES    FEMALES  MALES    FEMALES  MALES    FEMALES  ALIVE
---------------------------------------------------------------------
  0         6        6       0        0        0        0      12
            4        4       0        0        0        0       8

  1         0        0       4        4        0        0       8
            0        0       2        3        0        0       5

  2         0        0       2        3        0        0       5
            0        0       1        2        0        0       3

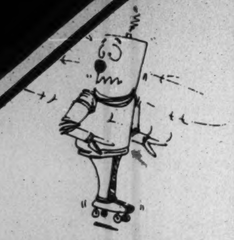
  3         1        0       0        0        1        2       4
            0        0       0        0        1        2       3

  4         1        1       0        0        1        2       5
            0        0       0        0        0        2       2

  5         0        0       0        0        0        2       2
            0        0       0        0        0        2       2

---------------------------------------------------------------------
```

TRS-80 LEVEL II



Pursuit Games, CS-3004 (16K)

- **Stock Car Race** $7.95

Stock Car Race is a real time racing game on a road race circuit. Your high speed racer is controlled by the "arrow" keys, as you shift up and down through four gears. Take the turns slowly, "floor it" on the straights, but don't blow your engine!

- **Maze**

Maze for the Level II 16K machine is a high speed pursuit game. You are timed throughout your run and rated on the basis of elapsed time and the number of moves required to escape. A different maze every time. Nine skill levels.

- **Indy Racer**

Indy Racer is a real time racing game for the TRS-80. You're in the driver's seat of a red-hot Indy car, changing gears and weaving around the track as you pass your competitors. Indy Racer is similar to the popular arcade-style driving games.

- **Depth Charge**

As commander of a destroyer, your mission is to destroy as many enemy subs as possible. Move your ship back and forth on the water, positioning yourself over enemy subs as they cruise into range. Depth charges sink slowly, so timing and position are important in this re-creation of the Battle of the Atlantic.

- **Kaleidoscope**

This graphics demonstration program turns your TRS-80 into a computer age kaleidoscope. You enter the number of lines and size of the display to produce changing patterns on the video monitor. Truly hypnotizing, Kaleidoscope runs continuously to brighten up your home or office.

WRITE FOR...

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SOFTWARE CATALOG

CIRCLE 300 ON READER SERVICE CARD

Space Games-3, CS-3002 (16K)

- **Ultra-Trek** $7.95

Ultra-Trek is a fast-paced version of Star Trek, complete with "real time" action graphics, lasers, Nilon space mines, high energy photon torpedoes, enemy ships that move, and an experimental ray which does something different each time you use it. You must act quickly to save yourself and the Federation.

- **Star Lanes**

Imagine yourself the president of an intergalactic shipping company. If you're successful, you may be named Imperial Advisor on Economic Affairs. Entrepreneurs: to your ships.

- **Star Wars**

If you hate Darth Vader, you'll love Star Wars. This real time game is fun for aliens of all ages. May the Force be with you!

- **Romulan**

Your mission is to destroy an invading Romulan space craft. Maneuver through space and around stars looking for the deadly enemy, but be careful! The nasty Romulans fire back.

How To Order

Send order and payment to **Creative Computing**, P.O. Box 789-M, Morristown, NJ 07960. Add $1.00 shipping and handling per order (foreign, $2.50) N.J. residents add 5% sales tax. Visa, MasterCharge and American Express orders welcome. For faster service, call in your bank card order toll free to: **800-631-8112.**(In NJ, call (201) 540-0445.)

sensational software

Strategy Games, CS-3005 (16K)

- **Tunnel Vision** $7.95

You are transported into a massive labyrinth and must find the exit or be lost forever. This is an excellent example of three dimensional perspective using TRS-80 graphics.

- **Evasion**

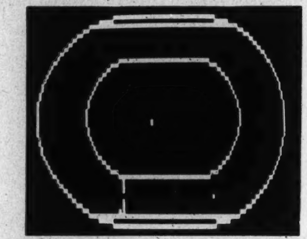
In this real time game, you are pursued around the game board by an evil-looking snake. Variations of play include two different speeds and hyper-jumps which randomly relocate you on the board. Looking for an escape? Try Evasion.

- **Jigsaw**

Jigsaw is a computer-age puzzle game making extensive use of TRS-80 graphics. The computer generates a random puzzle and puzzle board. Using a combination of deductive reasoning and luck you must fit the graphically represented puzzle piece into place.

- **The Masters**

Are you a wandering pro or just a Sunday golfer who would like to keep in practice? Once you're on the green, a worm's-eye view is displayed for putting.



- **Motor Racing**

Motor Racing combines real time racing action with advanced graphics functions. The graphics and animation make Motor Racing fun to watch as well as play.

Adventure

Welcome to an astonishing new experience! **ADVENTURE** is one of the most challenging and innovative games available for your TRS-80.

- **Adventureland**

You wander through an enchanted world trying to recover the 13 lost treasures and encounter WILD ANIMALS, MAGICAL BEINGS, and many other perils and puzzles.

CS-3008 TRS-80 16K Level II	$14.95
CS-3506 TRS-80 48K DISK (Includes Pirate Adventure)	$24.95

- **Pirate Adventure**

Can you recover LONG JOHN SILVER's lost treasure.

CS-3007 TRS-80 16K Level II	$14.95
CS-3506 TRS-80 32K DISK (Includes Adventureland)	$24.95

- **Mission Impossible Adventure**

Will you be able to complete your mission in time? Or is the world's first automated nuclear reactor doomed?

CS-3009 TRS-80 16K Level II	$14.95
CS-3507 TRS-80 32K DISK (Includes Voodoo Adventure)	$24.95

- **Voodoo Castle**

Count Cristo has had a fiendish curse put on him by his enemies. Will you be able to rescue him or is he forever doomed?

CS-3010 TRS-80 Level II	$14.95
CS-3507 TRS-80 32K DISK (Includes Mission Impossible)	$24.95

- **The Count**

You'll love this Adventure; in fact, you might say it's LOVE AT FIRST BITE . . .

CS-3011 TRS-80 Level II	$14.95

Economic and Ecology Simulations

The Ecology Simulations series are a unique educational tool. They are based on "simulation models" developed by the Huntington Two Computer Project at the State University of New York at Stony Brook under the direction of Dr. Ludwig Braun. The programs and accompanying documentation are written for self-teaching or classroom use and include background material, sample exercises and study guides. Graphic displays were specially developed by Jo Ann Comito at SUNY and Ann Corrigan at Creative Computing. The Ecology Simulations packages are a remarkable educational application of micro-computers.

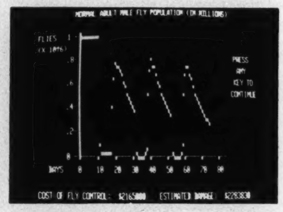
Ecology Simulations-1, CS-3201 (16K)

1. Pop

The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical, and logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

2. Sterl

STERL allows you to investigate the effectiveness of two different methods of pest control—the use of pesticides and the release of sterile males into the fly population. The concept of a more environmentally sound approach versus traditional chemical methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.


NORMAL ADULT MALE FLY POPULATION (IN MILLIONS)
FLIES
(X 10↑6)
1
.8
.6
.4
.2
0
DAYS
0
10
20
30
40
50
60
70
80
PRESS
ANY
KEY TO
CONTINUE
COST OF FLY CONTROL: $2165000
ESTIMATED DAMAGE: $2283830

3. Tag

TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by "tagging and recovery," TAG helps you to understand this process.

4. Buffalo

BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore "What if" questions and experiment with approaches that might be disastrous in real life.

Ordering Information

The series is designed for the 16K TRS-80 Level II and is attractively packaged in a vinyl binder with a complete study guide. *Ecology Simulations-I:* disk CS-3501, cassette 3201. *Ecology Simulations-II:* disk CS-3502, cassette CS-3204. *Social and Economic Simulations:* disk CS-3508, cassette CS-3204. At a modest $24.95 each, the series is an affordable necessity.

To order, send payment plus $1.00 shipping and handling to Creative Computing Software, Dept. ACGG, P.O. Box 789-M, Morristown, NJ 07960. For Faster Service, call in your order toll-free to our order hotline 800-631-8112. In NJ call 201-540-0445.

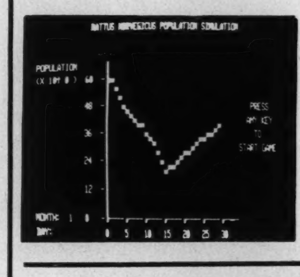
Ecology Simulations-2, CS-3202 (16K)

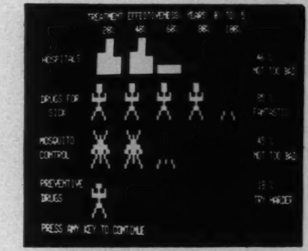
1. Pollute

POLLUTE focuses on one part of the water pollution problem; the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

2. Rats

In RATS, you play the role of a Health Department official devising an effective, practical plant to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in an apartment building or an entire city.





3. Malaria

With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budgeted use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

4. Diet

DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.

Social and Economic Simulations CS-3204 (16K)

1. Limits

LIMITS is a micro-computer version of the well known "Limits to Growth" project done at MIT. It contains a model of the world that is built of five subsystems (population, pollution, food supply, industrial output, and resource usage) linked together by six variables: birth rate, death rate, pollution generation, resource usage rate, industrial output growth rate, and food production rate.

2. Market

Market allows two or more people to play the roles of companies who are competing for the market for a particular product: in this case, bicycles.

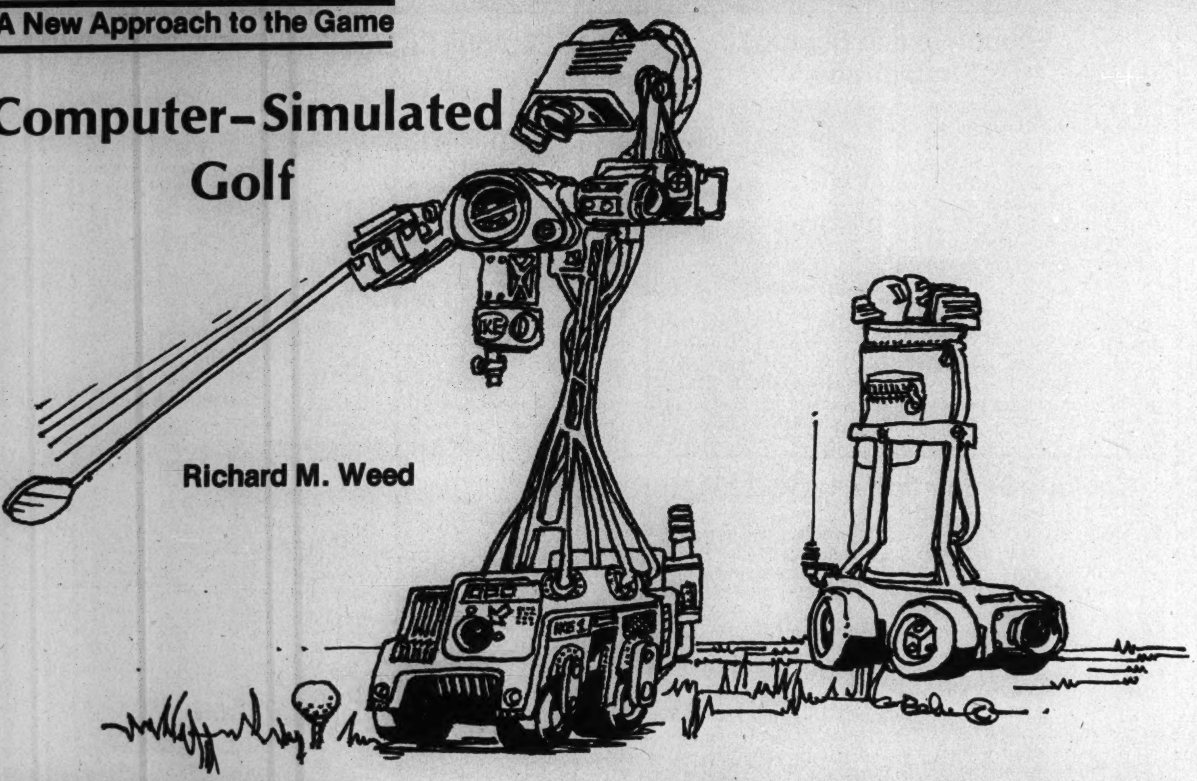
Each player makes marketing decisions quarterly including the production level, the advertising budget, and the unit price of the product for his/her company.

3. USPop

USPOP allows the user to study many aspects of the United States' human demography (population change) including population growth, age and sex distribution. USPOP makes population projections and investigates the consequences of many different demographic changes.

A New Approach to the Game

Computer-Simulated Golf



Richard M. Weed

Computer simulation resolves an age-old controversy regarding playing strategies. The author, a consulting engineer who specializes in applications of statistical analysis, has published several technical papers and a textbook on the uses of computer simulation. The study described in this article was undertaken as part of a graduate program in applied statistics.

Background

For years, serious golfers have debated whether it is better to charge or lag the longer putts. If the putt is for a tie at match play, there is no question that it should not be left short, but what about stroke play? And what about long putts for a win at match play? The player must try to make these putts but, when he misses, he must not leave the ball so far past the cup that he is liable to miss the shot coming back. This is clearly a strategy situation which suggests that an optimum strategy can be found.

Bobby Jones, one of the foremost players of his day, believed it was better to lag and, more recently, Jack Nicklaus has expressed similar thoughts. On the other hand, who can deny the success of Arnold Palmer, one of the boldest putters the game has known? Ask a number of experienced golfers whether it is better to charge or lag and you will receive a variety of very opinionated answers ranging from one extreme to the other. To resolve this controversy, the following questions must be answered:

a) Is there a single best putting strategy in any given situation?

b) Is the best putting strategy different for different players?

c) How does the length and type of putt determine the best strategy?

One way to answer these questions would be to have a number of golfers hole out many times using different strategies from varying distances on greens of various types. The total number of putts would be recorded to determine which strategy required the fewest strokes in the long run. However, a moment's reflection on the logistics of conducting such an experiment would discourage most people from trying it. The optimum putting strategy may be influenced by a particular golfer's ability in terms of distance and directional control so it would be necessary to measure these accurately for each of the participants. Golfers of different abilities would have to try various strategies from numerous distances under essentially identical conditions. This would be complicated by a gradual deterioration of the putting surface as more and more putts were attempted. A further complication would be the tendency for some players to improve throughout the duration of the experiment. Even if these technical difficulties could be overcome, the manpower, time and record keeping requirements would still be formidable obstacles.

Until recently, there was no other way a problem such as this could have been solved. Now, with the aid of modern computer technology, complex experiments of this type can be conducted in a matter of minutes by computer simulation.

How Computer Simulation Works

To understand how computer simulation works, suppose we wished to answer a question such as "What is the probability of throwing two heads in a row with a fair coin?" We really wouldn't need computer simulation to answer a simple question such as this because the probability can be calculated quite readily as $(\frac{1}{2})(\frac{1}{2}) = \frac{1}{4} = 25\%$. However, if we did choose to tackle it by simulation, we would first

---

Richard M. Weed, 61 Nancy Lane, Trenton, NJ 08638.

NEW! TPM* for TRS-80 Model II
NEW! System/6 Package
Computer Design Labs

Z80* Disk Software

We have acquired the rights to all TDL software (& hardware). TDL software has long had the reputation of being the best in the industry. Computer Design Labs will continue to maintain, evolve and add to this superior line of quality software.

— Carl Galletti and Roger Amidon, owners.

Software with Manual/Manual Alone

All of the software below is available on any of the following media for operation with a Z80 CPU using the CP/M* or similar type disk operating system (such as our own TPM*).

for TRS-80* CP/M (Model I or II)
for 8" CP/M (soft sectored single density)
for 5¼" CP/M (soft sectored single density)
for 5¼" North Star CP/M (single density)
for 5¼" North Star CP/M (double density)

BASIC I

A powerful and fast Z80 Basic interpreter with EDIT, RENUMBER, TRACE, PRINT USING, assembly language subroutine CALL, LOADGO for "chaining", COPY to move text, EXCHANGE, KILL, LINE INPUT, error intercept, sequential file handling in both ASCII and binary formats, and much, much more. It runs in a little over 12 K. An excellent choice for games since the precision was limited to 7 digits in order to make it one of the fastest around. $49.95/$15.

NEW MANUAL

BASIC II

Basic I but with 12 digit precision to make its power available to the business world with only a slight sacrifice in speed. Still runs faster than most other Basics (even those with much less precision). $99.95/$15.

NEW MANUAL

BUSINESS BASIC

The most powerful Basic for business applications. It adds to Basic II with random or sequential disk files in either fixed or variable record lengths, simultaneous access to multiple disk files, PRIVACY command to prohibit user access to source code, global editing, added math functions, and disk file maintenance capability without leaving Basic (list, rename, or delete). $179.95/$25.

NEW MANUAL

ZEDIT

A character oriented text editor with 26 commands and "macro" capability for stringing multiple commands together. Included are a complete array of character move, add, delete, and display function. $49.95./$15.

ZTEL

Z80 Text Editing Language - Not just a text editor. Actually a language which allows you to edit text and also write, save, and recall programs which manipulate text. Commands include conditional branching, subroutine calls, iteration, block move, expression evaluation, and much more. Contains 36 value registers and 10 text registers. Be creative! Manipulate text with commands you write using Ztel. $79.95/$25.

TOP

A Z80 Text Output Processor which will do text formatting for manuals, documents, and other word processing jobs. Works with any text editor. Does justification, page numbering and headings, spacing, centering, and much more! $79.95/$25.

MACRO I

A macro assembler which will generate relocateable or absolute code for the 8080 or Z80 using standard Intel mnemonics plus TDL/Z80 extensions. Functions include 14 conditionals, 16 listing controls, 54 pseudo-ops, 11 arithmetic/logical operations, local and global symbols, chaining files, linking capability with optional linker, and recursive/reiterative macros. This assembler is so powerful you'll think it is doing all the work for you. It actually makes assembly language programming much less of an effort and more creative. $79.95/$20.

MACRO II

Expands upon Macro I's linking capability (which is useful but somewhat limited) thereby being able to take full advantage of the optional Linker. Also a time and date function has been added and the listing capability improved. $99.95/$25.

LINKER

How many times have you written the same subroutine in each new program? Top notch professional programmers compile a library of these subroutines and use a Linker to tie them together at assembly time. Development time is thus drastically reduced and becomes comparable to writing in a high level language but with all the speed of assembly language. So, get the new CDL Linker and start writing programs in a fraction of the time it took before. Linker is compatible with Macro I & II as well as TDL/Xitan assemblers version 2.0 or later. $79.95/$20.

DEBUG I

Many programmers give up on writing in assembly language even though they know their programs would be faster and more powerful. To them assembly language seems difficult to understand and follow, as well as being a nightmare to debug. Well, not with proper tools like Debug I. With Debug I you can easily follow the flow of any Z80 or 8080 program. Trace the program one step at a time or 10 steps or whatever you like. At each step you will be able to see the instruction executed and what it did. If desired, modifications can then be made before continuing. It's all under your control. You can even skip displaying a subroutine call and up to seven breakpoints can be set during execution. Use of Debug I can pay for itself many times over by saving you valuable debugging time. $79.95/$20.

DEBUG II

This is an expanded debugger which has all of the features of Debug I plus many more. You can "trap" (i.e. trace a program until a set of register, flag, and/or memory conditions occur). Also, instructions may be entered and executed immediately. This makes it easy to learn new instructions by examining registers/memory before and after. And a RADIX function allows changing between ASCII, binary, decimal, hex, octal, signed decimal, or split octal. All these features and more add up to give you a very powerful development tool. Both Debug I and II must run on a Z80 but will debug both Z80 and 8080 code. $99.95/$20.

ZAPPLE

A Z80 executive and debug monitor. Capable of search, ASCII put and display, read and write to I/O ports, hex math, breakpoint, execute, move, fill, display, read and write in Intel or binary format tape, and more! on disk

APPLE

8080 version of Zapple

NEW

NEW! TPM now available for TRS-80 Model III!

TPM*

A NEW Z80 disk operation system! This is not CP/M*. It's better! You can still run any program which runs with CP/M* but unlike CP/M* this operating system was written specifically for the Z80* and takes full advantage of its extra powerful instruction set. In other words its not warmed over 8080 code! Available for TRS-80* (Model I or II). Tarbell, Xitan DDDC, SD Sales "VERSA-FLOPPY", North Star (SD&DD), and Digital (Micro) Systems. $79.95/$25.

SYSTEM MONITOR BOARD (SMB II)

A complete I/0 board for S-100 systems. 2 serial ports, 2 parallel ports, 1200/2400 baud cassette tape interface, sockets for 2K of RAM, 3-2708/2716 EPROM's or ROM, jump on reset circuitry. Bare board $49.95/$20.

ROM FOR SMB II

2KX8 masked ROM of Zapple monitor. Includes source listing $34.95/$15.

PAYROLL (source code only)

The Osborne package. Requires C Basic 2.
5" disks $124.95 (manual not included)
8" disks $ 99.95 (manual not included)
Manual $20.00

ACCOUNTS PAYABLE/RECEIVABLE (source code only)

By Osborne, Requires C Basic 2
5" disks $124.95 (manual not included)
8" $99.95 (manual not included)
Manual $20.00

GENERAL LEDGER (source code only)

By Osborne. Requires C Basic 2
5" disks $99.95 (manual not included)
8" disks $99.95 (manual not included)
Manual $20.00

C BASIC 2

Required for Osborne software. $99.95/$20.

SYSTEM/6

TPM with utilities, Basic I interpreter, Basic E compiler, Macro I assembler, Debug I debugger, and ZEDIT text editor.
Above purchased separately costs $339.75
Special introductory offer: Only $179.75 with coupon!!

NEW

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Golf, cont'd...

have to develop a random process which behaves exactly like the coin toss. Since a single toss of a fair coin has a 50% probability of producing a head, we could simulate this by drawing a single value from a table of random numbers ranging from 1 to 100 and calling the result a head if the random number is 50 or less. By drawing two random numbers, we could simulate the tossing of the coin twice and, if both numbers are 50 or less, we have accomplished the equivalent of throwing two heads. By repeating this procedure many times and counting the number of times the equivalent of two heads is obtained, it would be possible to obtain a very accurate estimate of the desired probability. (If this experiment actually were performed 10,000 times, it would nearly always produce an answer between 24% and 26%.)

For years, serious golfers have debated whether it is better to charge or lag the longer putts.

Upon reading this, your first thought might be that it would be just as simple to toss an actual coin and not bother with the random number table. This would be true if we had to make the random selections ourselves but, fortunately, the computer will do this for us. In fact, it is a simple matter to program the computer to perform the complete experiment, count the number of times two heads are obtained, convert this to a percentage and print out the answer. If we wish, we can even have the program calculate confidence limits about the experimental result so that we would know the maximum amount the true answer might deviate from the experimentally-derived result. For this example, the computer might have printed out 24.5 ± 1.0%, a range which includes the true value of 25%.

For those not familiar with the tremendous efficiency of modern digital computers, it is interesting to compare the speed of the computer with that of a person performing the same task. For the experiment just described, 10,000 repetitions amount to 20,000 single tosses of the coin. A person might be expected to make and record about 10 tosses per minute and, at most, would work about 50 minutes out of each hour, 8 hours per day. At this rate, a total of 5 days would be required. In contrast to this, the computer can complete this entire experiment in less than 5 seconds! It is this remarkable capability that makes computer simulation one of the most useful tools of modern science.

In order to apply this technique to our golf problem, three preliminary tasks must be accomplished. First, putting ability must be defined in a quantitative way that will be meaningful to the computer. Next, a mathematical way to describe the rolling of a golf ball into the cup must be found. Finally, a method to instruct the computer to try different putting strategies must be developed. All three of these tasks will be seen to be easier than might at first be expected.

First Task

Putting ability can be characterized by two variables, distance and direction. In order to describe a player's putting ability in terms of these variables, it is necessary to introduce a statistical term called the standard deviation. The standard deviation is a measure of how close a player can come, on the average, to what he aims at. The smaller the standard deviation, the better the player.

For those not familiar with the standard deviation and the manner in which it is calculated, the following example will provide a more intuitive feeling for what it represents. To determine his ability to lag a putt a given distance, suppose a player lays a string across a carpet and, from a distance of 20 feet or so, tries to hit each putt so that it will stop exactly at the string. Let's say the player putts at the string 30 times, each time recording the distance the putt actually traveled. Although very few putts may stop exactly at the string, the average length of travel of the 30 putts will be found to be quite close to the desired distance of 20 feet. Furthermore, there is a statistical rule which tells us that nearly all the putts will be within plus or minus three standard deviations from this average point, about 95% will fall within plus or minus two standard deviations, and approximately two thirds will lie within plus or minus one standard deviation. In this example, if we found that 20 of the 30 putts were within plus or minus one foot from the string, we would know that the standard deviation was about one foot. (Although the standard deviation can be estimated in this manner, direct calculation is best. Many hand calculators provide this capability.)

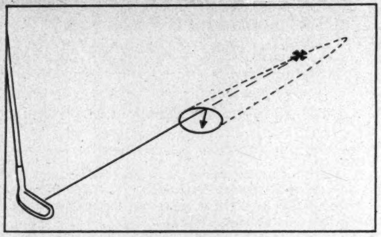
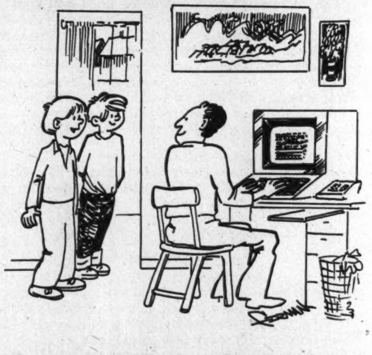


Figure 1. The Sink Zone

To simplify the application of this information to putts of lengths other than that used in the test, we will express the standard deviation in relative terms, that is, as a percentage of the length of the putt. If the standard deviation for a 20 foot putt has been estimated at 1.0 feet, the relative standard deviation would be 1.0/20 = 5%. Experimentation has shown that the relative standard deviation for the distance of a putt is nearly constant, being effected negligibly by the length of the putt and only slightly by the speed of the green.

The standard deviation for directional accuracy is determined in a



"Guess what, Dad, at Buddy's house all his games come in cardboard boxes and he doesn't even need a computer to play them!"

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VARIABLE	DESCRIPTION	VALUE
1	Number of putts to be attempted	1000
2	Length of putt	20 ft.
3	Directional ability (relative standard deviation)	4%
4	Distance ability (relative standard deviation)	8%
5	Length of sink zone	7 ft.
6	Maximum length for charging strategy	5 ft.
7	Maximum length for intermediate strategy	10 ft.

TABLE 1. A POSSIBLE SET OF INPUT VARIABLES

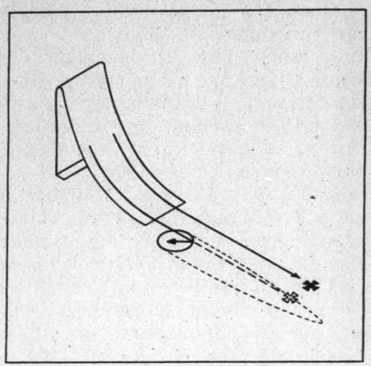
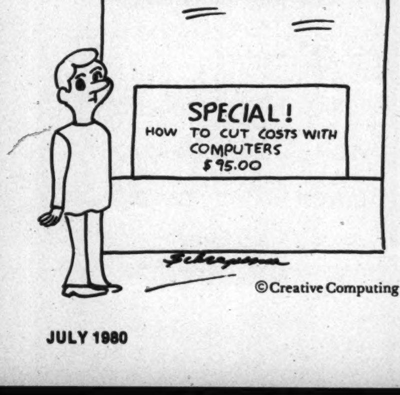


Figure 2. Establishing the Sink Zone

similar manner. In this case, the player putts at a target on a flat, true surface and the deviations left or right as the ball passes the target are recorded. As before, a relative standard deviation is calculated by dividing by the length of the putt.

Both relative standard deviations should be obtained from the same series of tests. This not only speeds up the process but provides a more realistic measure of how well a player can perform when he must be concerned about distance and directional accuracy simultaneously. (Ideally, this test should be performed on a putting green. However, it may be done on a carpet provided the player realizes that the results may be slightly better than he can expect to achieve on an actual green.)

This completes the first task, the development of a quantitative way to define putting ability. The relative standard deviations for distance and directional control will be among the input variables for the computer program, making it possible to simulate the testing of players of various abilities.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Second Task

The next task, finding a mathematical way to describe the rolling of a golf ball into the cup, is quite simple in concept. Basically, it consists of defining a "sink zone" which includes the cup and the area immediately behind it as shown in Figure 1. A putt which will drop into the side of the cup must be traveling very slowly as it reaches the cup whereas a putt hit into the center of the cup can be moving much more rapidly. The outer limits of the sink zone represent the maximum distance a successful putt would have rolled past the cup if the cup had not been there to catch it. Once the sink zone has been described in mathematical terms within the computer program, any simulated putt which stops within this area will be considered to have fallen into the cup.

It was necessary to establish the sink zone experimentally, using the ramp-type device shown in Figure 2. All sink zones were found to be of the shape shown in the figure although, as was expected, they extend for a greater distance past the cup on faster greens. In order to account for the speed of the green in the simulated putting experiment, the length of the sink zone will be included among the variables entered into the computer program.

Third Task

The final preparatory task is the easiest of the three. In order to compare the relative effectiveness of charging and lagging, these strategies must be described in a quantitative way. For a complete lagging strategy, approximately 50 percent of the total number of putts attempted will reach the cup. For a complete charging strategy, 100 percent will reach the cup. In order to provide an additional measure of realism, an intermediate strategy will also be included for which 75 percent of the putts will reach the cup. Since the relative standard deviation for distance is entered into the program, it is a simple matter for the computer to calculate what the average distance must be so that there is a 50, 75, or 100 percent chance of reaching the cup on any simulated putt.

In order to test different strategies, the computer must be told over what ranges of distance these three strategies are to be applied. For example, if it were desired to charge every putt up to 5 feet in length and be moderately aggressive between 5 and 10 feet, this can be accomplished by entering the two limiting distances, 5 feet and 10 feet, into the program. When this is done, the program will attempt to hit each simulated putt so that no 5 footers are left short and only about 25 percent of the 5 to 10 footers will be short. Above 10 feet, the lagging strategy will be in effect. In this manner, a wide variety of strategies ranging from very conservative to very bold can be tested.

The Simulation Experiment

In order to describe how the program actually conducts the experiment, it will be instructive to examine a possible set of input variables as shown in Table 1. This is all the information the computer needs to conduct one series of putting tests. Variables 1 and 2 tell the computer to hole out from a distance of 20 feet a total of 1000 times. Variables 3 and 4 specify a very good player in terms of distance and directional accuracy. Variable 5 represents a moderately fast putting surface with a sink zone length of 7 feet. Variables 6 and 7 indicate that a charging strategy is to be used on all putts up to 5 feet in length and an intermediate strategy is to be used between 5 feet and 10 feet. All putts longer than 10 feet will automatically be lagged.

> **A wide variety of strategies ranging from very conservative to very bold can be tested.**

For each simulated putt, the computer generates two normally distributed random numbers. These numbers, when combined with the dis-

```
PUTTS REQUIRED TO HOLE OUT        OCCURRENCES        STROKES
            1                          87                87
            2                         889              1778
            3                          24                72
            4                           0                 0
       MORE THAN 4                      0                 0
                                     1000              1937

STROKE AVERAGE = 1.937
```

TABLE 2. TYPICAL COMPUTER OUTPUT

	STANDARD DEVIATIONS (%)		
ABILITY LEVEL	DIRECTION	DISTANCE	DESCRIPTION
A	2	4	EXCELLENT PLUS
B	3	6	EXCELLENT
C	4	8	VERY GOOD
D	5	10	GOOD
E	6	12	FAIR

TABLE 3. LEVELS OF PUTTING ABILITY

tance to the cup, the relative standard deviations, and the desired strategy, determine the direction and distance the simulated putt travels. The program then calculates the point at which the putt stops and, if it is within the sink zone, the putt is considered to have fallen into the cup. Otherwise, the remaining distance between the ball and the cup is calculated, two more random numbers are drawn, and another simulated putt is made using the appropriate strategy from that point. This procedure is repeated until the putt is successfully holed out for each of the 1000 attempts.

The output for this run might appear as shown in Table 2. For this particular test, the player holed out on the first putt a total of 87 times, two putted 889 times, and three putted 24 times for a stroke average of 1.937. If some alternate strategy were to produce a stroke average of 1.783, for example, it would be considered a superior strategy because, on the average, fewer strokes were required. By trying several strategies ranging from very conservative to very bold, it will be possible to determine the optimum strategy if one exists.

To make the simulation more like an actual round of golf, an additional refinement must be added. Instead of specifying the initial length of each putt to be exactly 20 feet, we will instruct the computer to create a random distribution of putts similar to that which would be encountered in actual play. The average length of putt will still be approximately 20 feet but the individual putts will range in length from nearly zero up to a maximum of about 100 feet. This will allow us to evaluate our test strategies in terms of the effect they would have on an 18-hole round of golf.

Validation of the Program

Now there is only one step remaining before we can use a program to answer our questions about putting strategies. This is the validation step which simply means we must verify that the simulation program is a realistic model of the real process. If this article were written for a scientific journal, it would be necessary to devote a lengthy section to this topic. For our present purposes, it will suffice to briefly describe how this is accomplished.

Since we have complete control of the variables that are entered into the program, we can use slightly unrealistic values for which the results can be predicted in advance. For example, the directional standard deviation can be set at zero so that every simulated putt is exactly on line. A judicious choice of the other variables will enable us to predict how many times the player should hole out in one stroke. Then, provided the simulation outcome is not significantly different from the expected result, we would conclude that the program was working properly. A variety of different tests of this type were performed, all of which indicated that the program was operating correctly.

Ability and Strategy Levels

Since there are so many possible combinations of playing abilities and putting strategies, it will be necessary to define a manageable number of distinct groups. Experience has shown that a player's directional control is approximately twice as good as his control of distance. This information was used to establish the five ability levels listed in Table 3.

The top ability level is described as "excellent plus" because it is believed that few players can attain this degree of control. A touring professional might achieve it on a flat, consistent surface such as a carpet but more likely would fall into Ability Level B on an actual putting green. Better than average club players would probably fall into Ability Level C.

By remembering the rule about standard deviations, a player can estimate his ability without conducting an actual putting test. Since approximately 95% of the putts will come within plus or minus two standard deviations of the target, a player has only to estimate how widely dispersed the best 95% of his putts are. For example, if he is seldom off line by more than two feet to either side on a 20 foot putt, two feet equals two standard deviations and the standard deviation is one foot. In relative terms, it is 1/20 = 5% and, from Table 3, we see that a directional standard deviation of 5% corresponds to Ability Level D.

The standard deviation is a measure of how close a player can come, on the average, to what he aims at.

The putting strategies will also be divided into distinct groups. The intermediate strategy will be assumed to apply up to twice the maximum length for the charging strategy. For example, if the player plans to charge all putts up to 10 feet in length, he will use the intermediate strategy on putts between 10 and 20 feet in length. Putts longer than 20 feet would be lagged. The seven strategies to be tested are listed in Table 4.

The strategies range from very conservative to very bold so that all possibilities can be thoroughly investigated. For Strategy 1, the player charges putts up to 2 feet in length and begins lagging above 4 feet. For Strategy 7, the player charges everything up to 30 feet and doesn't begin to lag until the putt is over 60 feet in length.

For each of the 35 possible combinations of ability level and strategy, a minimum of 2000 simulated putting tests were conducted. In the critical regions near the optimum strategies, the number of tests was doubled. A seven foot sink zone was used for the main group of tests although additional tests with other lengths pro-

	RANGES FOR PARTICULAR STRATEGIES (FT.)			
STRATEGY	CHARGE	INTERMEDIATE	LAG	DESCRIPTION
1	0- 2	2- 4	OVER 4	VERY CONSERVATIVE
2	0- 4	4- 8	OVER 8	—
3	0- 6	6-12	OVER 12	CONSERVATIVE
4	0-10	10-20	OVER 20	—
5	0-15	15-30	OVER 30	BOLD
6	0-20	20-40	OVER 40	—
7	0-30	30-60	OVER 60	VERY BOLD

TABLE 4. PUTTING STRATEGIES

Golf, cont'd...

duced essentially the same results. All in all, the computer simulated holing out from varying distances a total of 130,000 times. (A group of 25 golfers might have required about a month to accomplish this. The computer required just about 11 minutes.

	STRATEGY						
	VERY CONSERVATIVE		CONSERVATIVE		BOLD		VERY BOLD
ABILITY LEVEL	1	2	3	4	5	6	7
A (EXC. PLUS)	1.732	1.707	1.685	1.665	1.648	1.634	1.622
B (EXCELLENT)	1.845	1.804	1.777	1.764	1.767	1.784	1.816
C (VERY GOOD)	1.944	1.894	1.873	1.879	1.914	1.976	2.067
D (GOOD)	2.060	2.016	2.006	2.030	2.087	2.179	2.305
E (FAIR)	2.158	2.124	2.130	2.176	2.261	2.387	2.553

TABLE 5. STROKE AVERAGE AS A FUNCTION OF ABILITY AND STRATEGY

Table 5 lists the stroke average for each combination of strategy and ability level. Here we see that optimum strategies do exist and that they are dependent upon a player's putting ability.

Since Ability Level B most nearly resembles the capability of a tour player on an actual putting surface, it will be interesting to examine these results more closely. We see that the lowest stroke average of 1.764 is obtained with Strategy 4 and that Strategy 5 produces very nearly the same result. Therefore, a player of this level of ability would score best by being fairly bold.

To appreciate the importance of the optimum putting strategy, it is necessary to determine the effect it has on an 18-hole round and a 72-hole tournament. A player of Ability Level B who uses the optimum putting strategy will require 1.764 × 18 = 31.8 putts per round, on the average. (This is a reasonable result for a tour player and provides added assurance that the simulation program is realistic.) If this same player elected to use a very conservative approach such as Strategy 1, he would require 1.845 × 18 = 33.2 putts per round, on the average. The difference of 1.4 putts per round corresponds to almost 6 strokes for a 72-hole tournament. With today's purses, this would amount to a loss of several thousand dollars in prize money!

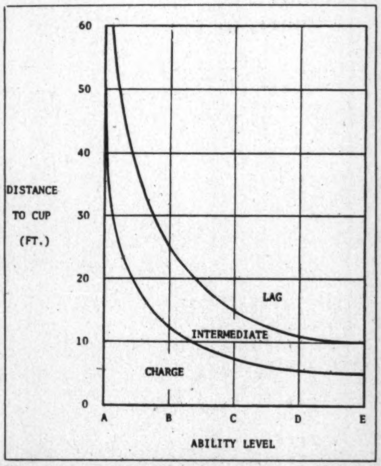


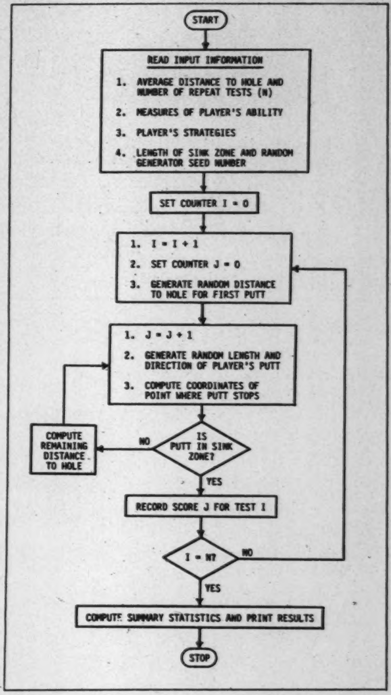
Figure 3. Optimum Strategy as a Function of Ability

The results of this study can best be summarized by the graph in Figure 3 which has been plotted from the data in Tables 4 and 5. Here we see that better putters can afford to be more aggressive while those with less ability should be more conservative. For example, the curves indicate that a player of Ability Level B should charge all normal putts up to a length of about 12 feet and be moderately aggressive up to about 25 feet. If a player could consistently perform at Ability Level A, he should charge almost any length putt. At the other end of the scale, a player of Ability Level E should still charge putts up to 5 feet in length and begin lagging at about 10 feet.

Finding a mathematical way to describe the rolling of a golf ball into the cup is quite simple in concept.

A word of caution is in order at this point. The optimum strategy is appropriate as long as the initial assumptions are met. However, if the putt has a large amount of break, the player's directional ability is likely to suffer. If the putt is downhill, the distance will be more difficult to control. In effect, conditions such as these can shift a player to a lower ability level and, as seen in Figure 3, this suggests a more conservative approach.

There is an additional aspect of tournament strategy that should be mentioned. Although the optimum strategy as defined in this study will allow a tour player to achieve the lowest stroke average of which he is capable, a somewhat bolder strategy may be required to maximize his chances of winning a tournament. However, because of the potentially disastrous outcome of an overly aggressive approach, this must be pursued with caution. To determine how productive a bolder strategy might be, a modification of the simulation program would be required. ☐


START
READ INPUT INFORMATION
1. AVERAGE DISTANCE TO HOLE AND NUMBER OF REPEAT TESTS (N)
2. MEASURES OF PLAYER'S ABILITY
3. PLAYER'S STRATEGIES
4. LENGTH OF SINK ZONE AND RANDOM GENERATOR SEED NUMBER
SET COUNTER I = 0
1. I = I + 1
2. SET COUNTER J = 0
3. GENERATE RANDOM DISTANCE TO HOLE FOR FIRST PUTT
1. J = J + 1
2. GENERATE RANDOM LENGTH AND DIRECTION OF PLAYER'S PUTT
3. COMPUTE COORDINATES OF POINT WHERE PUTT STOPS
IS PUTT IN SINK ZONE?
NO
COMPUTE REMAINING DISTANCE TO HOLE
YES
RECORD SCORE J FOR TEST I
I = N?
NO
YES
COMPUTE SUMMARY STATISTICS AND PRINT RESULTS
STOP

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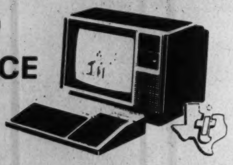

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Golf, cont'd...

Enter once for a series of runs

```
 run rwpsim text
EXECUTION BEGINS...

ENTER SINK ZONE (FT.), DIR. S.D. (%), DIST. S.D. (%), AND SEED NUMBER

7 2 4 1234567

ENTER LENGTH FACTORS A, B, AND C FOR TRANSFORMATION L=(A*R+B)**C
                                         This  creates  a skewed distribution
1 3.5 2.34                               of putts ranging in length from almost
                                         zero  to about 100 feet with an
                                         average length close to 20 feet.

 ENTER CHARGE AND SEMI-CHARGE DISTANCES (FT.) AND FORMAT CODE

->2 4 2

 SINK ZONE =  7.0 FT.
 A = 1.00       B = 3.5      C = 2.34
 DIRECTION STD. DEV. = 2.0%    DISTANCE STD. DEV. = 4.0%
 LONGEST PUTT = 86.61 FT.      SHORTEST PUTT = 0.83 FT.
 AVERAGE LENGTH = 20.76 FT.    SKEW COEFFICIENT = 1.05

             PUTTS REQUIRED        FREQUENCY
                   1                  280
                   2                  717
                   3                    3
                   4                    0
                   4+                   0

 AVERAGE NUMBER OF PUTTS REQUIRED = 1.723 <-
 ENTER CHARGE AND SEMI-CHARGE DISTANCES (FT.) AND FORMAT CODE
        Duplicate  runs  for each strategy in order to check
->2 4 2 "within strategy" variability.  As seen here, results tend to
        be quite close.
 SINK ZONE = 7.0 FT.
 A = 1.00      B = 3.50      C = 2.34
 DIRECTION STD. DEV. 2.0%     DISTANCE STD. DEV. = 4.0%
 LONGEST PUTT = 108.39 FT.    SHORTEST PUTT = .019 FT.
 AVERAGE LENGTH = 21.35 FT.   SKEW COEFFICIENT = 1.18

             PUTTS REQUIRED      FREQUENCY
                   1                265
                   2                734
                   3                  1
                   4                  0
                   4+                 0

 AVERAGE NUMBER OF PUTTS REQUIRED = 1.736 <-
```

Program Sample Run (Original Program in Fortran)

```
RUN PUTTSIM
EXECUTION BEGINS...

ENTER AVERAGE LENGTH (FEET) OF FIRST PUTT AND NUMBER OF TESTS
20 1000
ENTER STANDARD DEVIATIONS (%) FOR DISTANCE AND DIRECTION
8 4

ENTER CHARGE AND SEMI-CHARGE LIMITS (FEET)
10 20

ENTER LENGTH (FEET) OF SINK ZONE AND RANDOM GENERATOR SEED NUMBER
7 1234567

LONGEST FIRST PUTT = 86.61 FEET   SHORTEST FIRST PUTT = 0.83 FEET
AVERAGE LENGTH = 20.76 FEET       SKEW COEFFICIENT = 1.05

          PUTTS REQUIRED            FREQUENCY
                1                      177
                2                      750
                3                       71
                4                        2
                4+                       0
```

SPACE WAR

FLOOOOOM
WHOOOMPH
KPOW

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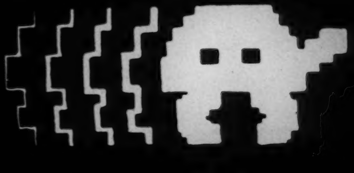

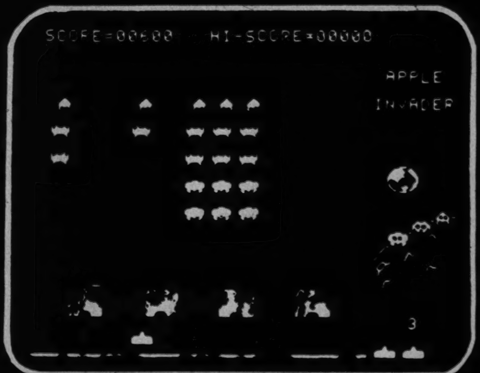

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Phone Words

Phil Hughes

The program Phone generates words from phone numbers. The words are made up from the letters on a telephone dial which correspond to the specified numbers. For example, 2 shares a dial position with the letters A, B and C. All letters except Q and Z appear on the dial, 3 per position corresponding to the numbers 2 through 9. The numbers 0 and 1 have no associated letters. The sample run in Figure 1 shows the results of running Phone with the number 837-8100.

I wrote Phone in TSC Basic which runs on a SWTPC 6800 computer system. With the exception of some machine-dependent code to selectively send the output to the printer or CRT terminal and to handle different page widths, the program is straightforward and should be easily convertible to most Basics.

Internally, Phone works as follows. Lines 30 through 100 set up the page width and select where the output is to be sent. In the end, variable LL should be set to the page width-7. Next, lines 130 and 140 setup array L$ with the possible valid characters for each digit. For example, L$(0) contains the character O and L$(5) contains the character string JKL.

Lines 150 through 260 get the seven digit number as a character string and convert it to seven integers which are stored in array P. Lines 270 through 310 compute the number of possible combinations. This is 2187 (3^7) if only the digits 2 through 9 appear in the number. For each 0 or 1, the possible number of

---

Phil Hughes, P.O. Box 2847, Olympia, WA 98507.

Figure 1

```
READY

LOAD 'PHONE'


READY

RUN

OUTPUT TO PRINTER? N
Enter phone number? 8378100
of (name, address or whatever)
? Test number
LINE UP WITH TOP OF PAGE AND HIT 'RETURN'.
?

Test number
837-8100 makes  81  different 'words'.


TDPT100   TDPU100   TDPV100   TDRT100   TDRU100   TDRV100   TDST100   TDSU100
TDSV100   TEPT100   TEPU100   TEPV100   TERT100   TERU100   TERV100   TEST100
TESU100   TESV100   TFPT100   TFPU100   TFPV100   TFRT100   TFRU100   TFRV100
TFST100   TFSU100   TFSV100   UDPT100   UDPU100   UDPV100   UDRT100   UDRU100
UDRV100   UDST100   UDSU100   UDSV100   UEPT100   UEPU100   UEPV100   UERT100
UERU100   UERV100   UEST100   UESU100   UESV100   UFPT100   UFPU100   UFPV100
UFRT100   UFRU100   UFRV100   UFST100   UFSU100   UFSV100   VDPT100   VDPU100
VDPV100   VDRT100   VDRU100   VDRV100   VDST100   VDSU100   VDSV100   VEPT100
VEPU100   VEPV100   VERT100   VERU100   VERV100   VEST100   VESU100   VESV100
VFPT100   VFPU100   VFPV100   VFRT100   VFRU100   VFRV100   VFST100   VFSU100
VFSV100

READY
```

Words, cont'd...

combinations is reduced by one power of 3.

Finally, lines 400 through 570 are seven nested FOR-NEXT loops that print the possible combinations. The innermost loop is for the last character so the resulting strings are in alphabetical order. Line 500 forces a carriage return when there is insufficient room for another string on the current line.

Enhancements, you say. Very few, except possibly checking for dirty words. ☐

Listing 1

```
10 REM PHONE - CONVERT PHONE NUMBER TO LETTERS
20 REM SSC V1.2 8-23-79
30 INPUT "OUTPUT TO PRINTER",Z$
40 LL=PEEK(HEX("AC04")):REM Get page width
50 IF LEFT$(Z$,1)<>"Y" THEN 100
60 OPEN "0.PRINT.SYS" AS 0
70 EXEC, "TTYSET PS=N"
80 INPUT "ENTER LINE LENGTH",LL
90 LL=LL-7
100 IF LL<7 THEN LL=73:REM Default to 80 cols.
110 DIM L$(9):REM LETTERS ON PHONE DIAL
120 DIM P(6)
130 DATA 0,1,ABC,DEF,GHI,JKL,MNO,PRS,TUV,WXY
140 FOR I=0 TO 9:READ L$(I):NEXT I
150 INPUT "Enter phone number",P$
160 IF LEN(P$)=7 GOTO 190
170 PRINT "Enter 7 digits"
180 GOTO 150
190 REM Get the digits as numbers
200 FOR I=0 TO 6
210 REM Convert digit to integer
220 P(I)=ASC(MID$(P$,I+1,1))-ASC("0")
230 IF P(I)>=0 AND P(I)<10 THEN 260
240 PRINT "Bad digit -- Try again"
250 GOTO 150
260 NEXT I
270 REM Figure # of combinations
280 C=1
290 FOR I=0 TO 6
300 C=C*LEN(L$(P(I)))
310 NEXT I
320 PRINT "of (name, address or whatever)"
330 INPUT LINE N$
340 PRINT "LINE UP WITH TOP OF PAGE AND HIT 'RETURN'."
350 INPUT LINE Z$
360 PRINT #0
370 PRINT #0,N$
380 PRINT #0,LEFT$(P$,3);"-";RIGHT$(P$,4);" makes ";C;" different 'words'."
390 PRINT #0:PRINT #0
400 FOR I0=1 TO LEN(L$(P(0)))
410 FOR I1=1 TO LEN(L$(P(1)))
420 FOR I2=1 TO LEN(L$(P(2)))
430 FOR I3=1 TO LEN(L$(P(3)))
440 FOR I4=1 TO LEN(L$(P(4)))
450 FOR I5=1 TO LEN(L$(P(5)))
460 FOR I6=1 TO LEN(L$(P(6)))
470 PRINT #0,MID$(L$(P(0)),I0,1);MID$(L$(P(1)),I1,1);MID$(L$(P(2)),I2,1);
480 PRINT #0,MID$(L$(P(3)),I3,1);MID$(L$(P(4)),I4,1);MID$(L$(P(5)),I5,1);
490 PRINT #0,MID$(L$(P(6)),I6,1);SPC(3);
500 IF POS(I)>LL THEN PRINT #0
510 NEXT I6
520 NEXT I5
530 NEXT I4
540 NEXT I3
550 NEXT I2
560 NEXT I1
570 NEXT I0
580 CLOSE 0
590 END
```

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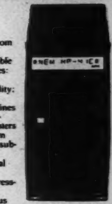

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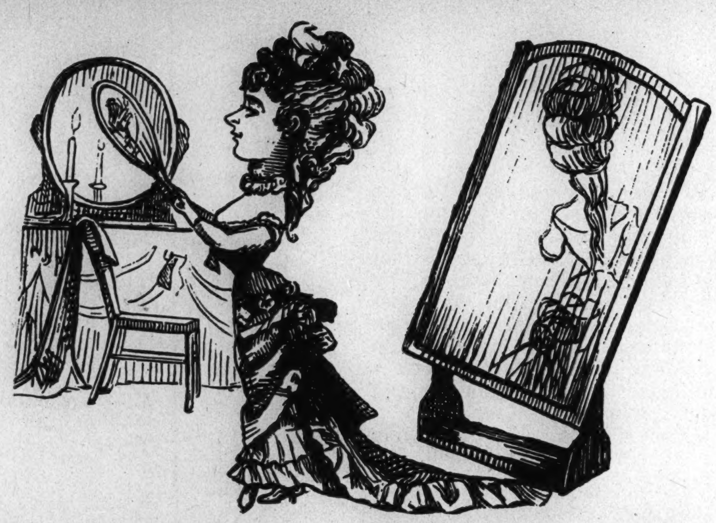
Self-Reproducing Programs



Louise Hay

An intriguing programming problem is to write a program which, when run with no input data, outputs *itself.* Such a program is analogous to the informal instruction WRITE WHAT YOU SEE, if what the instruction "sees" is itself. The possibility of constructing self-reproducing devices was demonstrated by John von Neumann (see *Theory of Self-Reproducing Automata,* edited by A. W. Burks, University of Illinois Press, Urbana, IL, 1966) by a proof that goes roughly as follows:

Note that this argument actually gives a recipe for writing a self-reproducing program: run the bootstrap program Pb with its own description as input!

Suppose we have a class of devices in which each device has a description, and in which a device M can be "joined" to a description y to give a new device M+y. The device with description y will be denoted by My. Now construct a "building" device which, when joined to a description y, builds the device My+y. This building device has a description, say b; thus Mb+y builds My+y. But then Mb+b builds Mb+b, so that Mb+b is self-reproducing.

A similar proof which is more directly applicable to programs is found in recursive function theory, where the properties common to all "standard" programming systems are analyzed. Here is the argument in its general form:

A program is a finite object — usually a finite sequence of instructions, i.e., a finite sequence of strings of symbols. The program can be thought of in two ways: as the finite object y that *describes* it, or as a function of its input (as when we say: run program P on input data x.) If y is a program description, we will denote the program it describes by Py when we wish to think of it as a function. The output obtained by running Py on input x will be denoted by Py(x); the output obtained by running Py with no input data is denoted by Py(). (In either case, if there is no output, this can be interpreted to be the null string.)

Now assume that programs can be given program descriptions as input data. (If the language has no string-handling capabilities, this may involve some complicated coding and decoding of strings into numbers and back again; this is feasible, if messy.) In "standard" programming systems, one can write a *bootstrap* program P which, when run with a program description y as input data, outputs a program description yy with the following property:

$$Pyy() = Py(y);$$

i.e., P(y) is a program which, when run on no input, simulates the program Py on input y. Let b be the description of the bootstrap program. Thus, for every program description y:

$$Pb(y) = yy$$

where: $Pyy() = Py(y)$

so that: $Pb(b) = bb$

and $Pbb() = Pb(b) = bb$!

Hence Pbb, when run on no input, outputs its own description, i.e., itself. Note that this argument actually gives a recipe for writing a self-reproducing program: run the bootstrap program Pb with its own description as input!

```
10 REM  THIS IS A BOOTSTRAP
20 DIM P$(800),X$(58)
30 N=13:L=58
40 S$=CHR$(32):B$=CHR$(80):D$=CHR$(36)
50 E$=CHR$(61):A$=CHR$(43):O$=CHR$(34)
60 FOR I=1 TO N
70 READ X$
80 P$=P$+X$
90 NEXT 1
100 PRINT 10;S$+P$(1,L)
110 PRINT 20;S$+P$(L+1,2*L)
120 FOR I=1 TO N
130 PRINT 20+10*I;S$+B$+D$+E$+B$+D$+A$+O$+P$(L*(I-1)+1,L*I)+O$
140 NEXT I
150 FOR I=3 TO N
160 PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)
170 NEXT I
180 STOP
READY
```

Listing 1. The bootstrap program.

```
190 DA!A "REM  THIS IS A SELF-REPRODUCING PROGRAM                    .
200 DATA "DIM P$(800)                                               .
210 DATA "S$=CHR$(32):B$=CHR$(80):D$=CHR$(36)                        .
220 DATA "E$=CHR$(61):A$=CHR$(43):O$=CHR$(34)                        .
230 DATA "N=13:L=58                                                  .
240 DATA "PRINT 10;S$+P$(1,L)                                      .
250 DATA "PRINT 20;S$+P$(L+1,2*L)                                  .
260 DATA "FOR I=1 TO N                                               .
270 DATA "PRINT 20+10*I;S$+B$+D$+E$+B$+D$+A$+O$+P$(L*(I-1)+1,L*I)+O$ .
280 DATA "NEXT I                                                     .
290 DATA "FOR I=3 TO N                                               .
300 DATA "PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)                        .
310 DATA "NEXT I                                                     .
READY
```

Listing 2. The data for the bootstrap program.

Louise Hay, 170 N. Scoville Ave., Oak Park, IL 60302.

Implementation in Basic

It is unrealistic to try to write a Basic program Pb which can accept all possible program descriptions as input, if only because of storage limitations. However, we are only really interested in running Pb with its own description b as input; hence, we can dimension storage accordingly. Roughly speaking, Pb should read in a sequence of strings y describing a program, then print out the sequence *twice*, once in the form of data initialization to replace READ instructions in Py, and once as the program Py with its READ instructions deleted. The resulting sequence yy will correspond to a program which, on no input, simulates Py on input y.

The bootstrap program Pb in Listing 1 was written in Maxi-Basic and run on a Digital Group Z-80 Computer. The program reads 13 input strings, say S1, S2, . . . , S13, and concatenates them into a string P$, it then outputs a program containing the following sequence of strings:

(a) assignment statements which set a string variable P$ to the concatenation of S1, S2, . . . , S13;

(b) the input strings S1, S2, . . . , S13 (i.e., the program that was read in as data), with line numbers added.

The program Pb is, of course,

```
10 RFM  THIS IS A SFLF-REPRONUCING PROGRAM
20 OIM P$(800)
30 P$=P$+"RFM  THIS IS A SFLF-REPRODUCING PROGRAM                    .
40 P$=P$+"nIM P$(800)                                                .
50 P$=P$+"S$=CHR$(32):R$=CHR$(80):D$=CHR$(36)                        .
60 P$=P$+"F$=CHR$(61):A$=CHR$(43):O$=CHR$(34)                        .
70 P$=P$+"N=13:L=58                                                  .
80 P$=P$+"PRINT 10;S$+P$(1,L)                                        .
90 P$=P$+"PRINT 20;S$+P$(L+1,2*L)                                    .
100 P$=P$+"FOR I=1 TO N                                               .
110 P$=P$+"PRINT 20+10*I;S$+B$+D$+F$+P$+D$+A$+O$+P$(L*(I-1)+1,L*I)+O$"
120 P$=P$+"NEXT I                                                     .
130 P$=P$+"FOR I=3 TO N                                               .
140 P$=P$+"PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)                        .
150 P$=P$+"NEXT I                                                     .
160 S$=CHR$(32):B$=CHR$(80):D$=CHR$(36)
170 E$=CHR$(61):A$=CHR$(43):Q$=CHR$(34)
180 N=13:L=58
190 PRINT 10;S$+P$(1,L)
200 PRINT 20;S$+P$(L+1,2*L)
210 FOR I=1 TO N
220 PRINT 20+10*I;S$+B$+D$+E$+B$+D$+A$+O$+P$(L*(I-1)+1,L*I)+O$
230 NEXT I
240 FOR I=3 TO N
250 PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)
260 NEXT I
READY
RUN

 10 REM  THIS IS A SELF-REPRODUCING PROGRAM
 20 DIM P$(800)
 30 P$=P$+"REM  THIS IS A SELF-REPRODUCING PROGRAM                    .
 40 P$=P$+"DIM P$(800)                                                .
 50 P$=P$+"S$=CHR$(32):B$=CHR$(80):D$=CHR$(36)                        .
 60 P$=P$+"E$=CHR$(61):A$=CHR$(43):Q$=CHR$(34)                        .
 70 P$=P$+"N=13:L=58                                                  .
 80 P$=P$+"PRINT 10;S$+P$(1,L)                                        .
 90 P$=P$+"PRINT 20;S$+P$(L+1,2*L)                                    .
 100 P$=P$+"FOR I=1 TO N                                              .
 110 P$=P$+"PRINT 20+10*I;S$+B$+D$+E$+P$+D$+A$+Q$+P$(L*(I-1)+1,L*I)+Q$"
 120 P$=P$+"NEXT I                                                    .
 130 P$=P$+"FOR I=3 TO N                                              .
 140 P$=P$+"PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)                       .
 150 P$=P$+"NEXT I                                                    .
 160 S$=CHR$(32):B$=CHR$(80):D$=CHR$(36)
 170 E$=CHR$(61):A$=CHR$(43):Q$=CHR$(34)
 180 N=13:L=58
 190 PRINT 10;S$+P$(1,L)
 200 PRINT 20;S$+P$(L+1,2*L)
 210 FOR I=1 TO N
 220 PRINT 20+10*I;S$+B$+D$+E$+P$+D$+A$+Q$+P$(L*(I-1)+1,L*I)+Q$
 230 NEXT I
 240 FOR I=3 TO N
 250 PRINT (N+I)*10;S$+P$(L*(I-1)+1,L*I)
 260 NEXT I
READY
```

Listing 3. The self-reproducing program with its output.

Self-Reproducing Program Revisited

Dennie Van Tassel

I received many solutions for this problem. For those of you that may have missed it in the Sep/Oct 1976 issue, here is the problem: Write a program that prints an exact copy of itself. No input statements are allowed.

Several people sent in solutions where they used the file the program was in or they created a file before hand, and then read the file. But this violated the rule that no input statements were allowed. Also there were several solutions sent in that required over a page of code.

Here are three good solutions, one in BASIC and two in FORTRAN. No COBOL solution was sent in, even though it is fairly easy in COBOL. It seems it should be possible to write a shorter BASIC version, but the solution is pretty good.

```
10 DATA "B$='DATA '+CHRS(34)
20 DATA "FØR J=10 TØ 180 STEP 10
30 DATA "READ A$
40 DATA "PRINT J;B$;A$
50 DATA "IF J<>90 THEN 170
60 DATA "RESTØRE
70 DATA "B$=''
80 DATA "NEXT J
90 DATA "END
100 B$='DATA '+CHR$(34)
110 FØR J=10 TØ 180 STEP 10
120 READ A$
130 PRINT J;B$;A$
140 IF J<>90 THEN 170
150 RESTØRE
160 B$=''
170 NEXT J
180 END
```

Basic solution by Donald Bell, a student at California State University at Fullerton.

```
REAL*8F(6)/48H(7X'REAL*8F(6)/48H'6A8,1H//7X'PRINTF,F'/7X'END')/
PRINTF,F
END
```

Fortran solution by Mark Barnett at Stanford University.

```
      WRITE(6,100)
      CALL EXIT
100    FØRMAT(T7,12HWRITE(6,100)/T7,9HCALL EXIT/
     12(48H 100    FØRMAT(T7,12HWRITE(6,100)/T7,9HCALL EXIT/
     1/T6,6H12(48H),T69,2H)/,T7,2(31H/T6,6H12(48H),T69,2H)/,T7,2(31H)/
     1T62,11H)/T7,3HEND),T6,2(28H1T62,11H)/T7,3HEND),T6,2(28H)/T7,3HEND)
      END
```

Fortran solution by Armond O. Friend of Brookline, Mass., a Freshman at MIT.

PRESS ON

Nothing in the world
can take the place
of persistence.
Talent will not;
Nothing is more common
than unsuccessful men
with talent.
Genius will not;
Unrewarded genius
is almost a proverb.
Education will not;
The world is full
of educated derelicts.
Persistence and determination alone
are omnipotent.

—Unknown

Self-Repro, cont'd...

independent of its data, and has 18 lines. The DATA for Pb is given in Listing 2. It consists of Pb with the following changes: the REM statement was modified, the READ loop was omitted to avoid having to delete it during execution, and the STOP statement was omitted (it was needed in Pb only because of a quirk in the way Maxi-Basic treats DATA containing the colon symbol:). Hence there are 13 input strings, as expected by Pb.

The main difficulty encountered in writing the program came from the fact that Maxi-Basic does not allow quotes inside quoted expressions. The program, however, requires instructions such as:

```
PRINT 30; "P$=P$+" + "QM" + P$(1,L) + "QM"
```

where QM denotes a quotation mark (to output an assignment instruction which concatenates a string P$ to the value of a string function; this value must appear between quotes in the assignment statement). Since QM cannot be replaced inside the quotes by a quotation mark, this effect is achieved by replacing QM by CHR$(34), a built-in function which returns the character whose ASCII code is 34 (namely, the quotation mark.) Since in addition the quoted expression "P$=P$+" would appear within quotes in the DATA strings, it must be replaced by the concatenation of the CHR$ values of the ASCII codes for P, $, =, and + (80, 36, 61 and 43 respectively). CHR$(32) is used to provide blanks. The output of the bootstrap program run with the given DATA is the self-reproducing program which appears, together with its output, in Listing 3.

Implementation in LISP

We include this section as propaganda for the use of the LISP language for symbolic manipulation. (For a description of the language, see BYTE, August 1979). It is much more straightforward to implement the general bootstrap function in LISP, for the following reasons:

(1) LISP programs are in the form of LISP data, and

(2) LISP was partly designed as a formalism for doing recursive function theory.

```
# (display b)

  (LAMBDA (Y)
     (LIST
        (LIST
           (QUOTE LAMBDA)
           NIL
           (LIST
              Y
              (LIST
                 (QUOTE QUOTE)
                 Y))))))
```

Listing 4. The bootstrap function

```
# (display (b b))

  ((LAMBDA NIL
      ((LAMBDA (Y)
          (LIST
             (LIST
                (QUOTE LAMBDA)
                NIL
                (LIST
                   Y
                   (LIST
                      (QUOTE QUOTE)
                      Y))))))
       (QUOTE
          (LAMBDA (Y)
             (LIST
                (LIST
                   (QUOTE LAMBDA)
                   NIL
                   (LIST
                      Y
                      (LIST
                         (QUOTE QUOTE)
                         Y))))))))))
```

Listing 5. The self-reproducing form

Writing the self-reproducing form suggested by our method requires only the basic LISP functions LIST and QUOTE. The bootstrap function B is defined by the lambda-expression displayed in Listing 4. If the argument given to B is a lambda-expression Y, the value B(Y) will be a form (YY), where YY is a lambda-expression for a function of no variables which applies the function Y to the argument Y. When B is given its own definition as argument (an easy way to do this is to CSET the atom B to the value of GET(B EXPR) and then to evaluate (B B),) the result is the form displayed in Listing 5. This is a self-reproducing LISP form, which evaluates to itself.□

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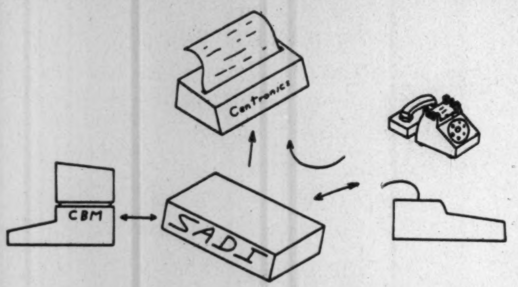

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In **Air Traffic Controller** you assume responsibility for the safe flow of air traffic within a 15x25 mile area up to 5,000 feet in altitude. During your shift as a controller in charge of this airspace, 26 aircraft become active and under your control. Jets and prop planes have to be guided to and from the two airports, navigational beacons and ten entry/exit fixes. The aircraft enter the controller's airspace at various altitudes and headings whether or not you are ready.

Air Traffic Controller retains the basic realism of air traffic control. This program requires the same steady nerves under pressure and the same instant, almost instinctive, analyses of complex emergencies which are demanded of a professional air traffic controller. But "ATC" adds the excitement and well-defined goals of a game. This is just a simulation, and all passengers left in air traffic limbo by a paniced player will live to fly another day.

Your goal is to get all of the aircraft to their assigned destination before the shift is completed. At your disposal are a radar display of the aircraft positions in the control area; coded information concerning aircraft heading, destination and fuel supply; navaids enabling you to hold aircraft or assign them automatic approaches; and commands to alter the altitude and heading of the aircraft. Working against you are altitude and heading requirements, fuel restrictions and, of course, the inimitable clock.

The most obvious measure of difficulty of a game is the clock setting at the beginning. In a 99 minute game you will have time to go fix a sandwich between the appearance of two successive aircraft, while in the 16 minute game you may not have time to swallow before all of the aircraft have appeared.

No two games, even at the same clock setting, are ever alike. As controller, you must cope with the unique requirements of each aircraft. The game will end if you commit a "boundry error," that is, if an aircraft fails to leave your area at the proper altitude and exit fix...causing an unpleasant surprise for the controller next door. The game also ends if you fail to leave a comfortable margin of safety between the aircraft as they whiz past each other. In cases of excessive delay, fuel supply considerations will become invested with a particular sense of urgency.

Successful guidance of all aircraft to their destination is a heady accomplishment. This never fails to thrill ATC enthusiasts at each successive level of play.

Your local retail store should carry Creative Computing Software. If your favorite retailer does not carry the software you need, have him call in your order to (800) 631-8112. Or you can order directly from Creative Computing. Write to Creative Computing Software, P.O. Box 789-M, Morristown, NJ 07960. **Air Traffic Controller** is now available for the 16K TRS-80 (3006), for the 16K Apple II and Apple II Plus (4008), the 8K Sorcerer (5008) and for the 4K Sol-20 (8001). All are on cassette for $9.95. Include $1.00 for postage and handling. For faster service, call in your bank card order toll free on our order hotline, (800) 631-8112.

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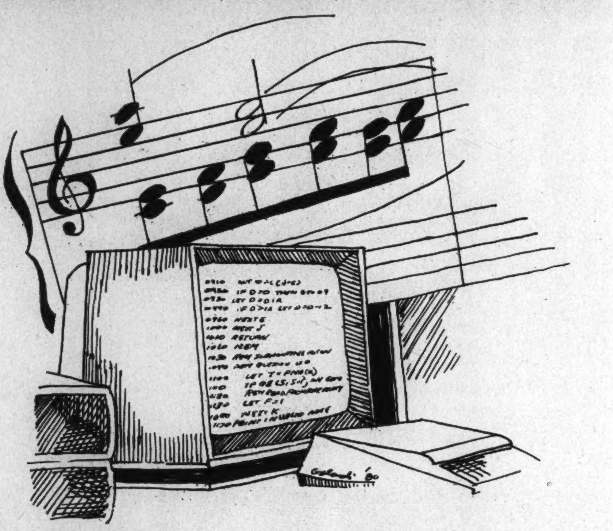
CIRCLE 350 ON READER SERVICE CARD

CHORD

A Program For Computer-Aided Music Transcription

Richard K. Lindgren



Most music-related computer programs use the computer to either compose or play music. Another practical use is in aiding the musician's or computer hobbyist's own skills in composing or transcribing music.

Often, when learning or composing a song using a piano or guitar, the musician will know only two or three notes of each chord. There may be several possible chords which have the known notes in common. This program will tell the user what those chords are, and what the unknown notes would be for each possible chord. The musician can then select the appropriate chord from the choices given.

> **There may be several possible chords which have the known notes in common. This program will tell the user what those chords are, and what the unknown notes would be for each possible chord.**

The chords are selected from ten of the most common in all twelve keys. The program will automatically respond in either flats or sharps, depending on which mode the user keys in the input. If the tonic note of the chord is known, the program will limit its search to that key only. By inputting a question mark as the first note, all twelve keys will be searched.

The program is written in Data General "Eclipse" Basic. The problems in converting to other systems, however, should be limited to variations in the use of character strings. Additional chords may be added by increasing the size of arrays C and C$, changing the chord count in line 1360, and adding additional chord data. The numbers representing each chord are simply the relative intervals of the halftones, numbered 1 through 12. □

Richard K. Lindgren, 15055 Salem, Redford, MI 48239.

```
*RUN
INSTRUCTIONS - Y OR N?
 ? Y
THIS PROGRAM FINDS CHORDS THAT CONTAIN NOTES INPUT BY THE
USER.  ENTER ONE OR MORE NOTES OF A CHORD AS THEY ARE
REQUESTED, FOLLOWED BY 'GO' WHEN READY TO SEARCH FOR CHORDS.
SHARPS SHOULD BE INDICATED BY '#' (E.G. C#), FLATS BY AN 'F'
(E.G. DF).  THE TONIC NOTE SHOULD BE INPUT FIRST.  IF
UNKNOWN, ENTER A '?' AS THE FIRST NOTE.

INPUT NOTE OR 'GO'
 ? A
INPUT NOTE OR 'GO'
 ? E
INPUT NOTE OR 'GO'
 ? C#
INPUT NOTE OR 'GO'
 ? GO

A            MAJOR        A  C# E
A            SEVENTH      A  C# E  G
A            MAJOR 7TH    A  C# E  G#
A            SIXTH        A  C# E  F#
A            NINTH        A  C# E  G  B
A            7 SUS 4      A  C# E  G  D

INPUT NOTE OR 'GO'
 ? ?
INPUT NOTE OR 'GO'
 ? BF
INPUT NOTE OR 'GO'
 ? DF
INPUT NOTE OR 'GO'
 ? F
INPUT NOTE OR 'GO'
 ? EF

EF           NINTH        EF G  BF DF F

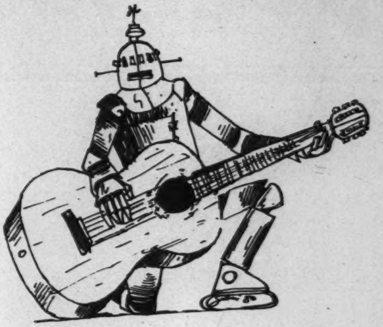
INPUT NOTE OR 'GO'
 ? EF
INPUT NOTE OR 'GO'
 ? GF
INPUT NOTE OR 'GO'
 ? BF
INPUT NOTE OR 'GO'
 ? C
INPUT NOTE OR 'GO'
 ? GO

NO CHORDS FOUND

INPUT NOTE OR 'GO'
 ? GO

STOP AT 1470
*
```

```
0010 REM PROGRAM TO FIND CHORD NAMES
0020 REM WRITTEN BY R.K.LINDGREN
0030 REM IN DATA GENERAL BASIC 1-30-80
0040 DIM N$[36],M$[36],C[10,5],C$[100],Q$[15],Q[5],Y$[1]
0050 REM DEFINE FUNCTIONS FOR FINDING START CHARACTER IN NOTE NAMES
0060 DEF FNA(P)=(P-1)*3+1
0070 REM SAME FOR CHORD NAMES
0080 DEF FNB(P)=(P-1)*10+1
0090 REM READ HALFTONE NAMES, SHARPS, THEN FLAT EQUIVALENTS
0100 READ N$
0110 READ M$
0120 REM READ NUMBER OF CHORDS,CHORD NAMES, THEN INTERVALS
0130 READ A
0140 FOR I=1 TO A
0150   LET S=FNB(I)
0160   READ C$[S,S+9]
0170   FOR J=1 TO 5
0180     READ C[I,J]
0190   NEXT J
0200 NEXT I
0210 PRINT "INSTRUCTIONS - Y OR N?"
0220 INPUT Y$
0230 IF Y$="N" THEN GOTO 0320
0240 PRINT "THIS PROGRAM FINDS CHORDS THAT CONTAIN NOTES INPUT BY THE"
0250 PRINT "USER.  ENTER ONE OR MORE NOTES OF A CHORD AS THEY ARE"
0260 PRINT "REQUESTED, FOLLOWED BY 'GO' WHEN READY TO SEARCH FOR CHORDS."
0270 PRINT "SHARPS SHOULD BE INDICATED BY '#' (E.G. C#), FLATS BY AN 'F'"
0280 PRINT "(E.G. DF).  THE TONIC NOTE SHOULD BE INPUT FIRST.  IF"
0290 PRINT "UNKNOWN, ENTER A '?' AS THE FIRST NOTE."
0300 REM
0310 REM READ IN NOTES
0320 LET I=0
0330 LET F=0
0340 LET P=0
0350 LET Q$="
0360 PRINT
0370 LET I=I+1
0380 IF I>5 THEN GOTO 0430
0390 PRINT "INPUT NOTE OR 'GO'"
0400 LET S=FNA(I)
0410 INPUT Q$[S,S+1]
0420 IF Q$[S,S+1]<>"GO" THEN GOTO 0370
0430 LET I=I-1
0440 IF I=0 THEN GOTO 1470
0450 PRINT
0460 REM CONVERT NOTES TO NUMERIC 1-12
0470 FOR J=1 TO I
0480   GOSUB 1050
0490   REM BIAS TO 1ST NOTE
0500   IF J<>1 THEN GOTO 0530
0510   LET B=Q[1]-1
0520   GOTO 0550
0530   LET Q[J]=Q[J]-B
0540   IF Q[J]<1 THEN LET Q[J]=Q[J]+12
0550 NEXT J
0560 IF Q[1]=0 THEN GOTO 0600
0570 REM RUN WITH 1ST NOTE AS TONIC
0580 GOSUR 0800
0590 GOTO 0760
0600 REM
0610 REM UNKNOWN TONIC, TRY THEM ALL
0620 LET Q[1]=1
0630 IF I<2 THEN GOTO 0320
0640 FOR H=1 TO 12
0650   REM GET TONIC NOTE
0660   LET D=H
0670   LET E=1
0680   LET B=H-1
0690   GOSUB 1240
0700   FOR D=2 TO I
0710     LET Q[D]=Q[D]-1
0720     IF Q[D]<1 THEN LET Q[D]=Q[D]+12
0730   NEXT D
0740   GOSUB 0800
0750 NEXT H
0760 IF P=1 THEN GOTO 0320
0770 PRINT "NO CHORDS FOUND"
0780 GOTO 0320
0790 REM SUBROUTINE TO SEARCH CHORD ARRAYS
0800 FOR J=1 TO A
0810   LET G=1
0820   FOR K=1 TO 5
0830     FOR L=2 TO I
0840       REM COUNT THE MATCHED NOTES
0850       IF Q[L]=C[J,K] THEN LET G=G+1
0860     NEXT L
0870   NEXT K
0880   IF G<>I THEN GOTO 1000
0890   REM ALL NOTES MATCH, PRINT THIS CHORD
0900   FOR E=1 TO 5
0910     LET D=C[J,E]
0920     IF D=0 THEN GOTO 0950
0930     LET D=D+B
0940     IF D>12 THEN LET D=D-12
0950     GOSUB 1240
0960   NEXT E
0970   LET S=FNB(J)
0980   PRINT Q$[1,2],C$[S,S+9],Q$
0990   LET P=1
1000 NEXT J
1010 RETURN
1020 REM
1030 REM SUBROUTINE TO CONVERT TO NUMERIC 1-12
1040 REM QUESTION MARK IS 0
1050 LET S=FNA(J)
1060 IF Q$[S,S]<>"?" THEN GOTO 1090
1070 LET Q[J]=0
1080 GOTO 1200
1090 FOR K=1 TO 12
1100   LET T=FNA(K)
1110   IF Q$[S,S+1]=N$[T,T+1] THEN GOTO 1190
1120  >IF Q$[S,S+1]<>M$[T,T+1] THEN GOTO 1160
1130   REM READ FROM FLAT ARRAY
1140   LET F=1
1150   GOTO 1190
1160 NEXT K
1170 PRINT "INVALID NOTE-",Q$[S,S+1]
1180 GOTO 0320
1190 LET Q[J]=K
1200 RETURN
1210 REM
1220 REM SUBROUTINE TO GET NOTE NAME, GIVEN NUMBER
1230 REM F=0,READ SHARPS; F=1,READ FLATS
1240 LET S=FNA(E)
1250 IF D<>0 THEN GOTO 1280
1260 LET Q$[S,S+1]="  "
1270 GOTO 1330
1280 LET T=FNA(D)
1290 IF F=1 THEN GOTO 1320
1300 LET Q$[S,S+1]=N$[T,T+1]
1310 GOTO 1330
1320 LET Q$[S,S+1]=M$[T,T+1]
1330 RETURN
1340 DATA "A  A# B  C  C# D  D# E  F  F# G  G# "
1350 DATA "A  BF B  C  DF D  EF E  F  GF G  AF "
1360 DATA 10
1370 DATA "MAJOR     ",1,5,8,0,0
1380 DATA "MINOR     ",1,4,8,0,0
1390 DATA "SEVENTH   ",1,5,8,11,0
1400 DATA "MINOR 7TH ",1,4,8,11,0
1410 DATA "MAJOR 7TH ",1,5,8,12,0
1420 DATA "DIMINISHED",1,4,7,10,0
1430 DATA "AUGMENTED ",1,5,9,0,0
1440 DATA "SIXTH     ",1,5,8,10,0
1450 DATA "NINTH     ",1,5,8,11,3
1460 DATA "7 SUS 4   ",1,5,8,11,6
1470 STOP
1480 END
```



puzzles & problems

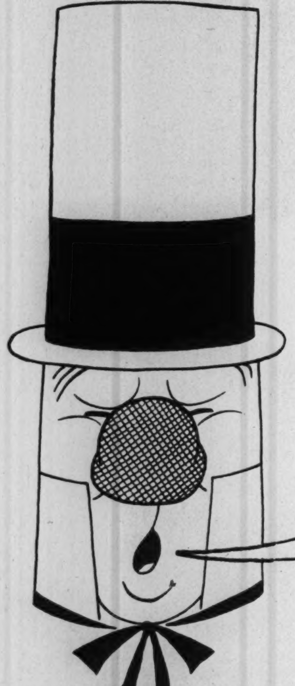
Merlin's Uncle Ezra has been working for days trying to find the solution to the following word puzzle sent in by Richard Reed of Broken Arrow, Oklahoma. It's a very good puzzle and Merlin is sending along a copy of "Merlin's Puzzler #1" to Mr. Reed. The object of the puzzle is to complete a paragraph using ten common English words. What makes it difficult is the way in which the words are formed. You start out with a one letter word and by adding only one letter to it make the second word. The third thru tenth words are formed in the same way by adding one letter to the previous word. Letters may be rearranged, but none may be dropped. Here is the Paragraph:

" _ think is a strange custom," said the man with the black _____, "and a peculiar___, but a fact that when we ________ a body, we________a_______memory of it. The _______________ of laws concerning_____ is proof of its ____."

Happy Adding

You'll be as happy as the little boy pictured here if you can discern the answer to the following puzzle submitted by our publisher's father, Mr. Howard Ahl of Palm Bay, Florida. A copy of "Merlin's Puzzler 2" is winging South.

If the digits 1 2 5 7 8 7 5 2 1 = 14 and
the digits 9 8 7 6 5 6 7 8 9 = 9 what do
the digits 1 2 3 4 5 6 7 8 9 equal?



The Egg And The Cannon Ball

Exhibiting an egg and a cannon ball (you can use a basketball), you hold forth learnedly on the extraordinary strength of a perfect arch, and, still more, of a perfect dome, remarking that few people know how strong even the shell of an egg is, if it is placed in a proper position. In proof of your assertion, you undertake to place the egg, without covering it in any way, in such a position that no one present can break it with the cannon ball. How can that be? (From "Puzzles Old and New" by Professor Hoffmann as reprinted in "Merlin's Puzzler 2").

Far A Fields

"As I was going to St. Ives, I met a man with seven wives, Each wife had seven sacks, Each sack had seven cats, Each cat had seven kits; Kits, cats, sacks, and wives, How many were there going to St. Ives?"

Innkeeper, a small libation, if you please. Thaumaturgical recitations dealing with puzzles leave me with an inordinate thirst!

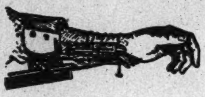
Mr. Fields has presented us with a pretty problem. Just how many are there going to St. Ives? He informs us that this is a very old English stumper. Innkeeper, another round while we work on this one. (From "Merlin's Puzzler 3")

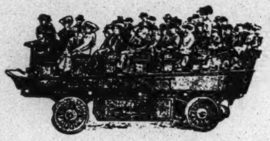
Answers on page 192.

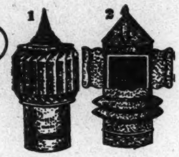
The Old Dictionary Quiz

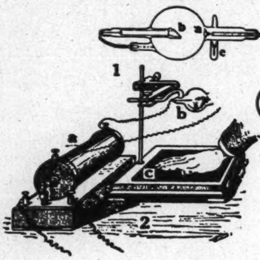
While browsing in a used book store I came upon an interesting old copy of a Funk and Wagnalls Dictionary from 1915. Following is a list of 14 words that I have selected from it. Can you match 7 of them to the pictures I've selected from the book? (See pictures along the left side of this page)

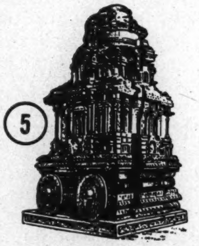
The words are: (A) Stereoscope, (B) Char-a-banc, (C) Xat, (D) Catalo, (E) Juggernaut, (F) Adjutant, (G) Bittern, (H) Peccary, (I) Uhlan, (J) Parbuckle, (K) Sphygmograph, (L) Fiacre, (M) Cowl, (N) Roentgen Rays

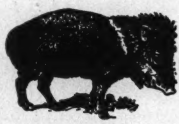
① 

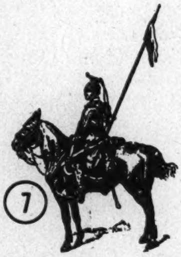
 ②

③ 

 ④

⑤ 

 ⑥

⑦ 

All Work And No Play

Here's a new change-the-word puzzle from Mr. Mark Kantrowitz of Brookline, Mass. He challenges our readers to change the word *PLAY* into the word *WORK* in eight steps. During each step the puzzler must change one letter in the previous word so that a new word is formed. (For example, you can change the word WARM into the word COLD in four steps: WARM, WARD, WORD, CORD, COLD). In Mr. Kantrowitz's solution one of the words formed is an abbreviation. Mr. Kantrowitz has requested a copy of "Merlin's Puzzler 1" which is on the way.

P	L	A	Y
W	O	R	K

A Puzzling Inscription

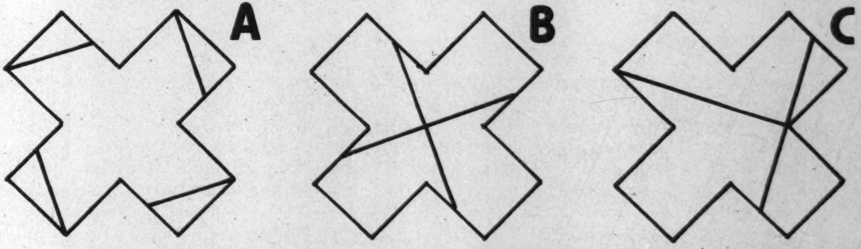
The following interesting inscription is said to be found in the chancel of a small church in Wales, just over the Ten Commandments. The addition of a single letter, repeated at various intervals, renders it not only intelligible, but appropriate to the situation:

PRSVRYPRFCTMN
VRKPTHSPRCPTSTN

What is the missing letter?

Don't Be A Square

To solve this puzzle you will first have to draw three Greek crosses on a piece of light cardboard. (A Greek cross is formed using five squares). Then, cut each cross into several pieces as indicated by the lines in our illustration. Cross *A* is cut into eight pieces and crosses *B* and *C* are each cut into four pieces. Now, your problem is to rearrange the pieces in each cross to form a perfect square.



I hope that these eight problems from Merlin provided entertainment for our readers. If you have a favorite puzzle why not share it with the rest of us? If Merlin uses it in his column he will send you a copy of one of his "Merlin's Puzzler" books, a gift that is always welcome.

Your Editor, Charles Barry Townsend. Charles Barry Townsend

Effective Writing

Carl E. Whitney

The Secret Life of Paragraphs

MPETITIVE.
INATIONS.
ORTIES.

"It's no fun being a paragraph. Your whole job is to keep out of sight. If you do your work well, people just skim through you, because they pick up your meaning with no effort. And what do you get for your trouble? A few periods and an exclamation point — if you're lucky.

"Oh, but if you slip up! *Then* they notice. 'You ugly, misshapen thing,' they say. 'You affront to reason! What are you doing on page 14 when you belong on page 15? And where did you pick up all that extraneous information? You should be ashamed of yourself! Why, if I were you, I'd go hide in the index.'

"'It's not my fault,' I tell them. 'My writer had gone three pages without a paragraph and figured it was time for a break. He's not too good with paragraphs. He doesn't understand that a paragraph should have some coherence, that it should develop a theme in a definite direction. He just lumped together some unrelated sentences and called them a paragraph. Can I help it if I was born ugly?'

"I try to educate my writer. 'Organize your writing into a sequence of topics,' I tell him. 'Each topic is a paragraph, and everything in that paragraph relates to that topic. And the topics go *bang bang bang* . . . one right after the other. When you come to a topic that doesn't go *bang*, because it's outside the logical flow you've established, then you're changing directions, and need a transition.'

"'What's a transition?' he asks. Imagine! Asking one of your own paragraphs what a transition is! This guy's poetic license should be revoked.

"'A transition,' I tell him, 'is a notice to the reader that the flow is somehow changing. It's also a statement of how the new direction is logically linked to the old one. For example, the word *But* at the beginning of a paragraph is a warning to the reader that you're shifting gears. A summary of what you've said, and an indication of the general topic on which you're about to embark, is a transition. Try writing very short sentences, or even sentence fragments, at turning points — you'll wake up the reader.

"'Always let the reader know where he stands,' I add authoritatively.

"'Anything else?' my writer asks.

"'Yeah,' I say. 'Verbs. For Gods sake give us some verbs to work with. Active, assertive, specific verbs. *There is* is a vague,general assertion.Can you be more specific? *May be* is also uninformative, unless you explain the reason for your uncertainty. *It is said that* and *it is known that* are lazy. Who says? Who knows? Can you quote them?'

"'You're pretty knowledgeable, for a paragraph,' my writer says.

"'A cousin of mine works for the encyclopedia,' I say. 'And another thing. Variety is the spice of life. Use different kinds of punctuation: question marks, colons, semicolons, dashes, quotation marks. Use your imagination. Do anything you can to enliven your message without distracting from it. Most writing is deadly dull.

"'But the most important thing of all is to be brief. Make every word count. My cousin told me a quip from a 19th century preacher and writer named Sydney Smith. It runs: "In composing, as a general rule, run your pen through every other word you have written; you have no idea what vigor it will give your style."'

"'Thanks,' says my writer. 'I'll keep it in mind.'

"He'll never learn."

The authorship of this column rotates, and this is the last in a series of three by yours truly. So it's a good time to bring up an important point. One does not "write" in the abstract; one communicates specific things to specific people. There is no such thing as "good writing"; there is only good communication in a particular place and time. *Never forget the reader.* It is his or her needs that dictate the proper style of writing.

For example, editors of microcomputer magazines usually ask writers to limit their use of technical terms to the bare minimum (though the minimum is sometimes a mouthful). There's a reason for this: the readers have varying amounts of technical knowledge, but editors want every reader to learn something from every article. A presentation appropriate for an engineering seminar is probably out of place here, because it would be over the heads of neophytes.

Write about your specialty, whether it's circuit design, interpreter oddities, or computers in education. But if you're writing for the general public, try to write coherently. See whether there is some way to make your message clear to the uninitiated.

Conversely, don't write a technical paper as if it were a magazine article. Your readers are going to study it, not glance at it to see if it's within their comprehension. Graduates of "good writing" classes sometimes object that their bosses want ponderous, turgid reports, not the lighter style that is usually taught in the classes. Fine. Write for your readers. All you want is that they understand you.

In *The Elements of Style*, E. B. White reminisces about the stylistic philosophy of the memorable William Strunk, Jr. "Will felt that the reader was in serious trouble most of the time, a man floundering in a swamp, and that it was the duty of anyone attempting to write English to drain this swamp quickly and get his man up on dry ground, or at least throw him a rope."

I hope that my suggestions will help you keep to the high ground. ☐

Carl E. Whitney, 846 Bush St. #3, San Francisco, CA 94108

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NEW SOFTWARE BY ROGER WAGNER

APPLE-DOC: This program set is a must to anyone writing or using programs in Applesoft! It not only provides valuable information on each of your programs, but allows you to change any element throughout the listing almost as easily as you would change a single line! With APPLE-DOC you can produce a list of every variable in your program and the lines each is used on, each line called by a GOTO, GOSUB, etc., in fact, every occurance of almost anything! You can rename variables, even do local or global replacement editing on your listing.

DISKETTE OR CASSETTE: $24.95 (14 pgs. documentation)
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THE CORRESPONDENT: At last an economical alternative to the higher priced text editors now available! THE CORRESPONDENT not only supports upper/lower case, but features character & line insert & delete functions. Output can be from 40 to 80 columns, with 4-directional scrolling to allow you to see exactly what will be output to the printer. It's very fast FIND routine makes it ideal as a free-form database for storing notes, phone lists, or anything where report generation is not essential. It will also access random or sequential text files — useful not only for the editing ability, but to examine & transfer data files, or for building your own EXEC files. routines are even included for putting the bidirectional scrolling in your own programs!

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PROGRAMMER'S UTILITY PACK: A collection of many useful programs to aid in programming the Apple II. This set includes: Renumber-Applesoft & Int.: Printer output of old/new lines, non-destructive to mach. code within BASIC listing. Append-Applesoft & Int.: Easily join one program or section thereof to another. Address/Hex Converter: Converts all of the Apple's address formats including high- and low-order bytes for pointers. Line Find-Applesoft & Int.: Find the location of any BASIC line in memory for repairing garbaged programs, or inserting illegal statements like HIMEM:, CLR directly into listings. And there are many more! The extensive (14 pgs.) documentation alone is worth the price! It includes an in-depth explanation of the internal workings of Integer BASIC and Applesoft to allow you to do things you never thought possible on your APPLE!

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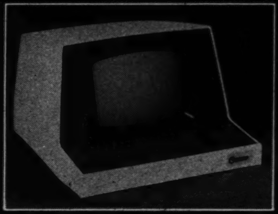

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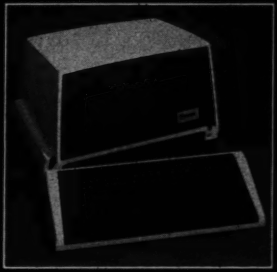

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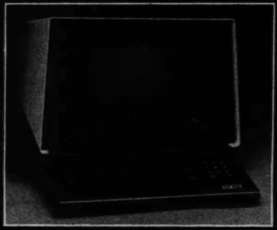

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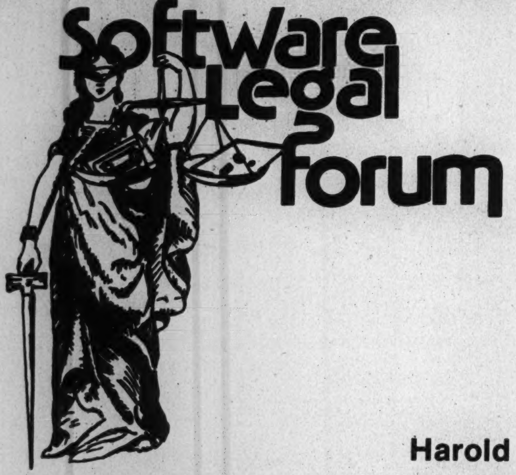
Software Legal Forum



The comments and opinions of the author are given for educational purposes only and are not meant to be legal advice. Specific legal questions should be referred to your personal attorney.

Harold L. Novick

The *Forum* appeared last in the May issue because this author missed his deadline for the June issue. Be thankful! You may never get another such break. Thus the promise to answer the argument by the Patent and Trademark Office (PTO) on why computer programs should not be patentable was not kept on time. Mea Culpa! However, read on, because here it comes.

Many critics, groups, organizations, corporations, and, yes, even governmental agencies have questioned and criticized the position that new and unobvious computer programs should be patentable subject matter. Some have even preicted that chaos would surely result if they are patentable. Do not be confused. All inventions, even software, in order to be patentable, must always be novel and unobvious. These people are saying that even given a new and unobvious computer program, it is not patentable because it is not patentable subject matter. It is hoped that they are wrong.

The government's position is essentially that all computer programs are algorithms, and algorithms, according to their interpretation of decisions of the Supreme Court of the United States, have been held to be unpatentable subject matter. This position, if carried to its logical extreme, would preempt the patentability of every novel and unobvious process or method ever devised. In a recent legal brief to the Supreme Court of the United States (*Diamond, Comm'r of Patents and Trademarks v. Bradley,* Petition for a Writ of Certiorari, Case No. 79-855), the government defines an algorithm very broadly as follows:

> 1. A fixed step-by-step procedure for accomplishing a given result; usually a simplified procedure for solving a complex problem, also a full statement of a finite number of steps. 2. A defined process or set of rules that leads and assures development of a desired output from a given input. A sequence of formulas and/or algebraic logical steps to calculate or determine a given task; processing rules.[1]

The PTO, if it had its way, would hold all "algorithms" to be unpatentable subject matter. Query: What process, be it a method for brewing beer, curing cancer, building a house, or manufacturing a chemical composition, is not a "fixed step-by-step procedure for accomplishing a given result"? Thus, by this definition of an algorithm, all processe would be unpatentable.

A procedure to determine whether a claimed invention that encompasses an algorithm falls within a class of patentable subject matter was set forth in the most recent Supreme Court case, *Parker, Acting Commissioner of Patents v. Flook,* 437 US 584, 198 USPQ 193 (1978), (Flook). The Court stated that if the claim (which is a concise written statement in a patent application of what the applicant regards as his or her invention) contains a mathematical formula, the formula must be considered to be old and the claim is not patentable unless there is some other inventive concept in it.

One commentator, using this procedure, applied the logical meaning of the government's definition of an algorithm to a slide rule, a machine and not a process. He states as follows:

> The PTO continues to allow patents on slide rules based on the type of mathematical algorithm performed thereby, while relying on Benson and Flook to deny patent protection to computer programs and methods of calculation solely suitable for execution by electronic data processing equipment. These positions are inconsistent and irreconcilable. There is no material difference between a mechanical calculator and an electrical or electronic one to justify such variance in treatment under the patent laws.[2]

Then he concludes:

> "The inconsistency between the PTO practice and the standards set forth in *Flook* indicates that the test for patentability of inventions embodying principles of nature is too restrictive a standard to be applied to innovations involving an algorithm."[3]

The PTO has a Board of Appeals that is the first stage in the process of appealing the Patent Examiner's refusal to grant a patent. This Board of Appeals, perhaps recognizing the absurdity of using a broadly defined algorithm to determine patentability, has attempted to limit its position to mathematical algorithms. However, not wanting to grant patents for computer programs, the Board tried to suggest that all computer programs are mathematical algorithms and thus they still are not patentable. Their reasoning is as follows:

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> [B]ecause a digital computer operates mathematically, employing numerical quantities according to at least one radix, appellants' claims [directed to a computer system for generating architectual specification and project control instructions] are directed to an algorithm — to the solution of a problem, which problem is stated in mathematical terms . . . the solution of the problem being effected mathematically by the computer. *In re Phillips,* 203 USPQ 971, 975 (CCPA 1979).

The Board also stated that all digital computers operate mathematically in solving problems "even though, to the user, the problem does not appear to be in mathematical form." The Court of Customs and Patent Appeals (CCPA), a reviewing court to which adverse Board decisions can be appealed, gave short shrift to the Board's opinion. The Board's position, in essence, is that because a digital computer "operates mathematically, employing numerical quantities according to at least one radix, all claims directed to computer-related inventions are directed to an algorithm [within the Supreme Court's meaning of that term]. We note that the radix merely defines a system of number representation and does not arithmetically calculate the solution to a mathematical problem . . . *In re Phillisp,* supra, at 975. The Board clearly erred in finding [that the claim recites a procedure for solving a mathematical problem]. *In re Phillips,* supra, at 975.

Obviously, the PTO Board of Appeals is trying to prevent the patenting of all computer programs and the CCPA is trying to make sense of all previous Supreme Court pronouncements. The difficulty is that the Supreme Court only wants to award patents for those inventions which promote the useful arts and does not want to grant them for inventions that would hinder this promotion. Therefore, the Supreme Court refuses to allow the basic tools of scientific and technological work, such as phenomena of nature, mental processes, and abstract intellectual concepts to be patentable subject matter. Not being a scientific body, not being trained in the physical sciences and engineering, the Supreme Court often writes inarticulate opinions when it tries to express this view. Knowing this, the PTO and the Department of Justice appeal the patentability of esoteric inventions to the Supreme Court so that no matter what the Court holds, there will be something in the decision which they can use to advance their position.

What does this mean to the software community? Patents for software will be expensive, and the fight could go to the Supreme Court. There will be long delays before protection is obtained (a patent can be used to stop others from making, using, or selling the patented invention only after it has been granted). Because a patent application is secret only before the PTO, your computer program will become known if you appeal the PTO's probable decision of unpatentability.

However, an attempt should still be made to patent certain types of computer programs. If the program does not solve a mathematical algorithm, is very valuable, has a long life time, and can be discovered through use, then the best protection may be from patents. More about this cannot be written at this time because, once again, the Supreme Court has agreed to review two cases involving the question of the patentability of new and unobvious "computer programs." These decisions could alter all of the rules of the game.

The first case is the above mentioned *Diamond v. Bradley.* The invention involves an improved method of using firmware for changing the data in scratchpad registers of some high performance computers. The CCPA described the invention as follows:

> Specifically, the invention relates to altering or repositioning information in the computer's system base. The system base of a computer is a fixed area in main memory which acts as the root for all information structures in the computer. In high performance computer systems, it is very advantageous to store portions of the system base in "scratchpad" registers located in the central processing unit (CPU) of the computer rather than in main memory. This greatly enhances the speed of operation of the computer because the access time (the time it takes to retrieve information from a given place) associated with the scratchpad registers is less than that associated with main memory. A problem arises, however, because a programmer may wish to change the positions or content of information in the system base which happens to be located in the scratchpad registers. These registers are "invisible" to the programmer since, unlike main memory, they cannot be accessed by software (computer programs). Prior art systems altered the system base information resident in the scratchpad registers by either reinitializing the system base (completely reloading the system base containing the new information), a process which consumes a considerable amount of time, or by using software which takes advantage of the model-dependent properties of the particular computer. The latter method has the undesirable effect of resorting to reliance on model-dependent software, which is unacceptable to some computer users.
>
> Appellants' invention enables system base information to be altered without having to resort to these techniques and their accompanying drawbacks. They accomplish their result by employing a "firmware" module, consisting of hardware elements permanently programmed with a microcode, which directs the data transfers, between the scratchpad registers and the system base located in main memory, which are necessary to effect the alteration.

The invention in the other case relates to a direct digital control method of operating rubber molding presses. A programmed digital computer is provided with a data base that includes natural logarithm conversation data, an activation energy constant based on the compound being molded, a constant based on the geometry of the molding press, the elapsed time since the press was closed, and the temperature of the mold. The computer then repetitively calculates the required cure time based on a well known mathematical equation (the Arrhenius equation). When the cure time equals the elapsed time, the computer provides a signal to open the press.

The *Bradley* firmware invention clearly does not involve a mathematical algorithm while the *Diehr* rubber molding method clearly does. It will be interesting to see what the Supreme Court does.

Next month this column will return to software copyrights and will be written by a guest author, Martha R. Gore of Tucson, Arizona. ☐

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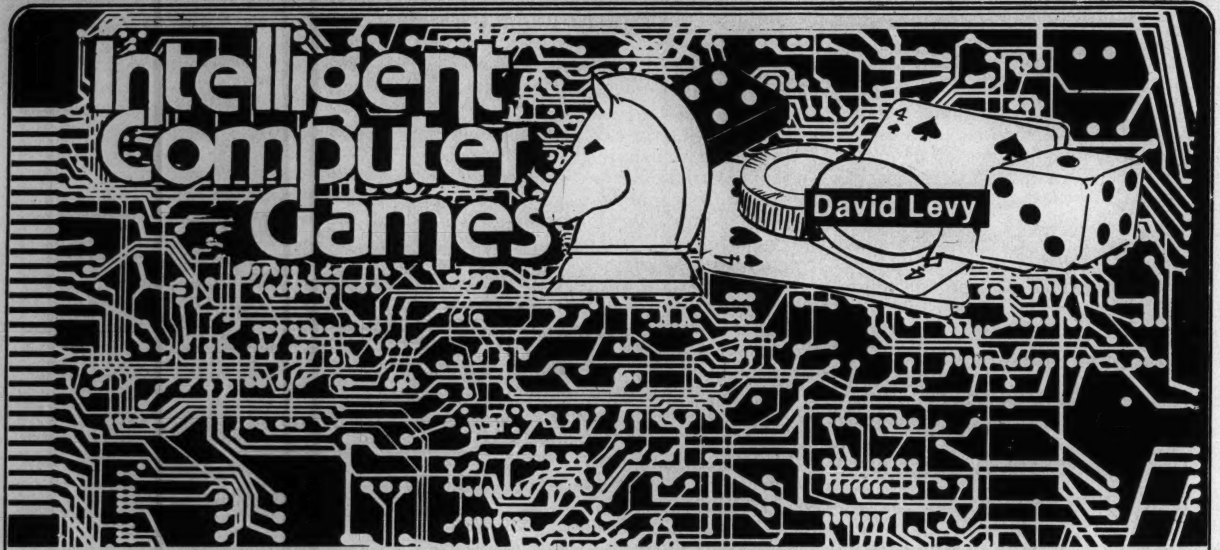
1 C. Sipple & C. Sipple. *Computer Dictionary and Handbook* 23 (2nd ed. 1972).

2 Gorenstein, "The Dual Standard of Patentability: A New Look at the Computer Issue," 62 JPOS 96, 103 (Feb. 1980).

3 Gorenstein, supra, at 106 and 107.

4 *In re Bradley,* 202 USPQ 480, 482 (CCPA 1979), cert. granted sub nom. *Diamond v. Bradley.*

5 *In re Diehr,* 203 USPQ 44 (CCPA 1979), cert. granted sub nom. *Diamond v. Diehr.*



Intelligent Computer Games

David Levy

Correspondence is welcome. Letters with interesting questions and ideas will be used in the column along with a response. No personal replies can be made. Send to: David Levy, 104 Hamilton Terrace, London NW8 9UP, England

All of the games that have been discussed so far in this series have been full information games, that is to say, each player knows exactly what forces are at his opponent's disposal and therefore what moves his opponent may make. This month we shall consider some of the problems posed by games in which this information is not readily available, and perhaps the best example of this type of game is a card game. When playing a game of cards you usually know which cards you have been dealt, but normally you will not see the cards that have been dealt to your opponent(s). You may be able to deduce certain things about an opponent's card holding from the way in which he bids or plays, but it is unlikely that you will know exactly what he holds until very near the end of the hand. Decisions made in this sort of environment must be made on a probabilistic basis, in other words, you play with the odds and hope for the best. If you have calculated the odds correctly you will win more often than you lose.

Shuffling

Before proceeding to the main point of this month's article I should perhaps interpose a brief section on how to shuffle the cards in your program. The simplest method that creates a randomly sorted deck is as follows. Starting with the deck in any order you wish (even perfectly sorted), interchange the first card in the deck with the Rth card, where R is a pseudo-randomly chosen integer on the range 1 to n (n is the total number of cards in the deck). Then interchange the second card with another randomly chosen card, then the third, and so on to the end of the pack. The manner in which you generate your random numbers is of some consequence — I would recommend that while developing your program you use one of the seeding methods in which the i+1-th random number is generated from the i-th number, and the series is started with a "seed" which may be chosen by the user. This approach has the advantage that if you spot a bug in your program you can recreate the hand simply by starting with the same seed. Once your program is debugged you may use the computer's internal clock to supply the seed, for example, by using the time elapsed between the pressing of two keys.

One seeded random number generator which will suffice is:

$$R_i = a^i \times \text{seed} \pmod m$$

where R_i = i-th pseudo-random number

$a = 8t \pm 3$ (for any positive integer t)

$m = 2^b$ where b is the number of bits per word in your computer

Deducing Information from the Play of the Cards

For the purpose of creating a simple example I have invented the following card game. The game is played by three players who are each dealt 17 cards at the start of a hand. The 52nd card in the deck is turned face up and that suit is trumps. Starting with the player on the dealer's left, the player leads a card and the other players must follow suit if they can, or they may trump if they wish (provided that they are unable to follow suit). The player who wins one trick leads to the next, and the player who wins most tricks wins the hand.

Let us assume that we are dealt the following hand:

```
SPADES (trumps): A K 4 2
HEARTS: Q 10 7 5
DIAMONDS: K 10 9 6 2
CLUBS: J 8 6 4
```

and that the 7 of spades is the card turned up. It is our turn to lead first.

At the start of the hand we know absolutely nothing about which cards our opponents hold, except for the fact that between them they hold all 34 of the unseen cards. But we do not have any indication as to how these 34 cards are distributed between the unseen hands, so the probability of each of the cards being in a particular hand is 0.5. We can therefore begin to construct, for each of our opponents (Bill and John) probability estimates for each card in the deck. At the start of the hand the estimates for each of them will be as follows:

	A	K	Q	J	10	9	8	7	6	5	4	3	2
SPADES:	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.0
HEARTS:	0.5	0.5	0.0	0.5	0.0	0.5	0.5	0.0	0.5	0.0	0.5	0.5	0.5
DIAMONDS:	0.5	0.0	0.5	0.5	0.0	0.0	0.5	0.5	0.0	0.5	0.5	0.5	0.0
CLUBS:	0.5	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.0	0.5	0.0	0.5	0.5

Assume that we lead the 4 of spades, and that the next player (Bill) plays the 9 of spades and the third player (John) takes the trick with the Q. What have we learned about the

Games, cont'd...

probabilities of the other cards, if anything?

Before answering this question I must explain an important theorem from Probability Theory, called Bayes' theorem.

Bayes' Theorem

Let us suppose that there are two bags, each containing five balls. Bag A contains 1 white and 4 black balls, Bag B contains 3 white and 2 black balls. I take a ball at random from one of the bags, and the ball is white. What is the probability that I took the ball from bag A?

The probability that a ball selected at random from bag A will be white is 1/5.

The probability that a ball selected at random from bag B will be white is 3/5.

Bayes' theorem shows that the probability that a randomly selected white ball actually came from

$$\text{bag A} = \frac{1/5}{(1/5 + 3/5)} = 1/4.$$

The reader will be able to generalize from this example, and the application to our game of cards will soon become apparent.

What have we Learned?

Let us now return to the question of what, if anything, we have learned about Bill and John's hands from the cards they played to trick one. We probably cannot say very much at all about Bill's hand at the moment, but we already know something about John's cards.

John took the first trick with the Q of spades. The A and K are in our own hand and so the only cards that John could possibly have used to take the trick were the Q, J and 10. If John had held the Q and 10 but been missing the J, he would have played the 10, so from the fact that he played the Q we know that his original spade holding included:

Q, J and 10 *or* Q and J *or* Q (without J or 10)

Now we can use the tables of probabilities for the individual cards to determine the *a priori* probability that John held each of these three holdings:

Probability that he held the Q, J and 10 = 0.5 × 0.5 × 0.5 = 0.125

Probability that he held the Q and J but not the 10 = 0.5 × 0.5 × 0.5 = 0.125

(Note that since the probability of his holding the 10 is 0.5, the probability of his not holding it is 1–0.5=0.5)

Probability that he held the Q but not the J or 10 = 0.5 × 0.5 × 0.5 = 0.125

And from Bayes theorem we can show that the probability that the Q came from each of these three holdings is:

Q,J,10: 0.125/(0.125+0.125+0.125)=1/3
Q,J: 0.125/(0.125+0.125+0.125)=1/3
Q: 0.125/(0.125+0.125+0.125)=1/3

Note that had the calculations been performed later in the hand, when the probabilities were not all equal (0.5), the final values would not all have been 1/3.

From these last calculations we can see that the probability that John holds the 10 of spades is 1/3 (in which case he also holds the J), and the probability that he holds the J is 2/3. We can therefore adjust the probabilities for the individual cards in John's hand as follows:

For the 10 of spades:
probability=0.333
For the J of spades:
probability=0.667
For all other unseen cards the probabilities are equal, and these are:

$$\frac{16-0.333-0.667}{32-1-1} = \frac{15}{30} = 0.5$$

since there are 16 unseen cards in John's hand, and 32 unseen cards in total (the probabilities of the J and 10 of spades being in John's hand are subtracted from the number of cards in his hand, and one is subtracted for each of them from the total number of unseen cards).

If the probability of the J of spades being in John's hand is 0.667, then the probability of it being in Bill's hand is 0.333, and by the same argument the probability of Bill holding the 10 of spades is 0.667. So we have been able to make some adjustments in the probabilities simply on the basis of John having played the Q of spades at trick one. We can also make note of the fact that if John ever shows the 10 of spades, we will know that he holds the J.

At trick two, John must lead because he won trick one. He leads the A of hearts, we play the 5, and Bill trumps with the 8 of spades. What have we learned from trick two? First of all, Bill would obviously use his lowest trump or one of his lowest contiguous group of trumps. The 7 was the original face up card, we played the 4 on trick one and Bill played the 9. We hold the 2 of spades and so Bill's 8 of spades must have been played from one of the following holdings:

3,10,8,6,5,3:
J,10,8,6,5:
J,10,8,6:
J,10,8:
10,8,6,5,3:
10,8,6,5:
10,8,6:
10,8:
8,6,5,3:
8,6,5:
8,6:
8:

and by using Bayes' theorem we can determine the probabilities of each of the above cards being in Bill's hand, and from these probability estimates we can determine estimates for the cards being in John's hand. We can also adjust the probabilities for all the hearts: those which are not in our own hand must all be in John's hand.

Deducing Information from Bidding

In many card games there is a bidding phase between the deal and the play of the cards. The best known of such games is Bridge, but the popular German game of Skat is another widespread example (it is said that Skat can be played by more than 50% of the entire population of Germany). Since each bid has a meaning, it should be possible for the card playing program to learn something about its opponents' hands from the way they bid, and it can then adjust its probability estimates for each card in their hand. How this is done will obviously vary from one game to another. Let us take a brief look at bridge, to see how we might modify the probability estimates of the unseen cards in the light of the bidding.

We are sitting South and hold 10 high card points. We look at the 13 cards in our hand and assign a probability of 1/3 to each of the remaining 39 cards in each of the other three hands. West opens the bidding and bids one spade, indicating that he has a stronger than average hand and that spades is his best suit. (Of course, this bid can mean other things, but we shall assume for this example that the above meaning is correct in the particular bidding system that West and his partner employ.) We may now adjust the probabilities of the spades, so that each spade in West's probability array has a slightly higher probability (say 0.45 instead of 0.33), and we may also adjust the probabilities of the high valued cards (aces, kings, queens and jacks) so that they give an expected high card holding which corresponds to a typical one spade opening bid. (If this bid is made with an average of 13 points, the ace counting 4 points, king 3, queen 2 and

Games, cont'd...

jack 1, then by making each of the high card probabilities 0.433 we give West an expectation of 13 out of the remaining high card points: there are 40 high card points in total and we hold 10 of them, leaving 30, and 13/30= 0.433). We should, in fact, give a slightly higher probability to a card which is both a spade and a high card.

Having assigned new probabilities to the spades and the high cards, we can then adjust the probabilities for the remaining cards in West's hand, so that the sum total of his probabilities is 13 (the total number of cards in his hand), and we can adjust the probabilities for each card in North's and East's hands by subtracting West's probability from 1 and dividing the result by 2, remembering to ignore all cards in our own hand.

So from his first bid we can make quite a lot of probabilistic estimates about West's cards, and hence about those in the North and East hands.

The bidding then passes to North, and depending on his bid we make adjustments to his probabilities using similar, logical arguments, and then we adjust the probabilities for West and East. This process continues until the end of the bidding — each time we acquire some information that increases the likelihood of a card being in a particular place, we increase the probability for that place and reduce it accordingly in the other hands. When there is some negative information about the position of a card we use it in a similar way.

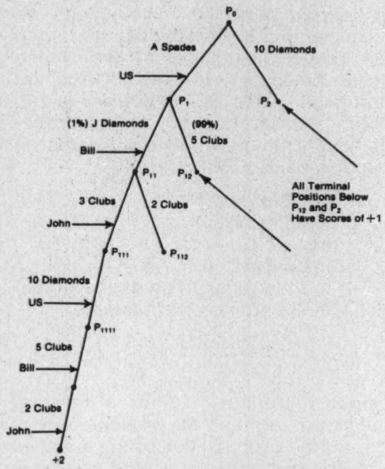
By the end of the bidding phase a good bridge program should have a fairly accurate estimate of how each of the other three hands is made up. By summing the probability values for all the spades in a hand the program can get an estimate of how many spades that player holds. By summing the products of the high card probability x high card point values, the program can estimate the number of high card points in each suit in each hand. It will then be better able to plan its play of the hand, and of course the probabilities will be adjusted all through the playing phase.

How to use Deduced Information

The most obvious use of our deduced probabilities arises when the probability estimates for all unseen cards are all either 1 or 0, i.e., we know where all the remaining cards lie. We then have a case of a perfect information game, and we can solve this game by performing a tree search to the end of the game. Even though there may be three or more players, the tree approach should still work, though we must make certain assumptions about the way that the other players are going to make their decisions. For example, let us assume that we are two tricks from the end of a hand of our three-player card game.

We hold: A of spades, 10 of diamonds.
Bill holds: J of diamonds, 5 of clubs.
John holds: 3 and 2 of clubs.
It is our turn to lead (remember that spades are trumps).

The program now constructs a game tree, of depth 6-ply. Part of the tree will look like this:



We assign to the terminal nodes of the tree, scores corresponding to the number of tricks won by each player, and we back up through the tree until we can determine which card should be played next. In this example the situation is simple because if we lead the A of spades first we **may** take two tricks, whereas if we lead the 10 of diamonds we can only make one trick. Note the use of the word "may." In order to make two tricks we need some help from Bill, who must make a mistake and discard the J of diamonds in the hope that our second card is the 2 or 3 of clubs and he will make his 5. But since we lose nothing by playing the A of spades first, that is clearly the best way to continue. How can we modify our traditional methods of tree-searching to cater for situations such as this one, in which we wish to allow for the possibility that our opponent will make a mistake? Fortunately the problem has been solved for us, by the ubiquitous Donald Michie, whose name crops up time and again in interesting research reports on various topics within the science of Artificial Intelligence.

Expected Values in Backed-Up Trees

Michie's method, which I shall discuss in some detail in a later article, is based on the assertion that when searching a game tree it is unreasonable to assume perfect play by the opponent, since there must always be a finite chance that he will not choose the best move. Let us see how this helps us to search the above tree.

We may simplify Michie's concept as follows: If there is a 99% chance that Bill will play the 5 of clubs from position P_1, and a 1% chance that he will play the J of diamonds, then since the 5 of clubs will give us a score of 1 (i.e., we take one trick) and the J of diamonds will give us a score of 2, the expected value of us of position P_1 is

$$(0.99 \times 1)+(0.01 \times 2)=0.99+0.02=1.01$$

whereas if we play the 10 of diamonds from position P_0, the expected (in fact the certain) value of position P_2 will be 1 (i.e., we will take one trick no matter how Bill and John play). Since 1.01 is greater than 1, we should play the A of spades from P_0 because it maximizes our expected score. The reader will probably have realized by now that not only does Michie's method allow us to optimize our practical chances when we **know** exactly where all the unseen cards lie, it also enables us to use our probability estimates of the locations of the unseen cards, to build game trees which will help in the play of the hand. In other words, Michie has shown us how to play with the odds!

Task for the Month

Find or invent a simple card game in which information may be deduced from the play of the cards. (Avoid bidding games, unless you are extremely confident and have many free hours this month.) Write a program to play this game, modifying the probability estimates of the unseen cards in the light of the user's play. Experiment with various methods of adjusting these estimates until the program plays at least moderately sensibly. At the point in the game where exhaustive search will not be too time consuming, set up a probabilistic game tree a la Michie to search to the end of the game. ☐

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(For more information on Bayes' theorem see any good book on statistics or probability theory.)

Creative Computing can help you select the best computer and get the most out of it.

With so many new personal computers being announced and the prices coming down so rapidly, isn't the best bet to wait a year or so to buy a system?

We think not. A pundit once observed that there are three kinds of people in the world: 1) those who make things happen, 2) those who watch things happen and 3) those who wonder what happened. Today, it is those who are getting involved with microcomputers who are making things happen by learning to use computers effectively.

Furthermore, it is not likely that we will see the same dramatic price declines in future years that have already taken place. Rather, one will be able to get more capability for the same price.

The TI-99/4 has excellent color graphics and costs $1150 including color TV monitor.

Which system is for you?

No two people have exactly the same needs. You'll have to determine what capabilities are important to you. Key variables include:

- Upper and lower case. Obviously vital if you are planning to do word processing or anything with text output.
- Graphics. Most systems have graphics but the resolution varies widely. How much do you really need?
- Color. Some systems are B&W, some have 4 colors, others up to 256 colors. Many colors sounds nice, but do you really need 4, or 16, or more?
- Mass storage. The smaller systems are cassette based; larger systems offer floppy disks or even hard disks. What size data bases do you intend to use and is it important to have high-speed random access to an entire data base?
- Languages. Basic is standard but increasingly Pascal, Fortran, Cobol and special purpose languages are being offered.
- Audio, Speech, Music. Are these features important for your planned applications?
- Applications Software. Third party software is widely available for some systems, non-existent for others. Do you need this, or can you write your own?

Unbiased, in-depth evaluations.

At Creative Computing, we obtain new systems as soon as they are announced. We put them through their paces in our Software Center and also in the environment for which they are intended — home, business, or school. We published the first in-depth evaluations of the Texas Instruments 99/4, Atari 800, TRS-80, Ohio Scientific Challenger, Exidy Sorcerer, Apple II disk system and Heath H-8. We intend to continue this type of coverage, not only of systems, but peripherals and software as well.

Sorting: A Key Technique

While evaluations are important, the main focus of Creative Computing magazine is computer applications of all kinds. Many of these require that data be retrieved or sorted. Unfortunately, most programming texts focus on the bubble sort (or straight insertion) and, very infrequently, another technique (usually delayed replacement) and let it go at that.

Yet, except for comparison counting, the bubble sort is the least efficient. Tutorials and articles in Creative Computing demonstrate that the Shell-Metzner and Heapsort are from 50 to 13,000 times as fast as the bubble sort! Consider a sort of 100,000 items on a DEC System 10:

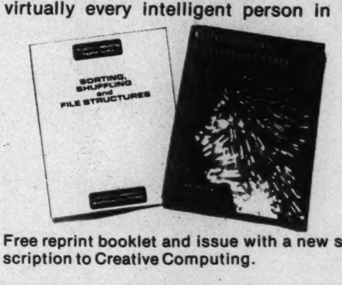
Bubble sort	7.1 days
Delayed replacement	3.8 days
Heapsort	17.3 minutes
Shell-Metzner	15.0 minutes

Needless to say, on a microcomputer, a bubble sort of even 1000 items is agonizingly long.

Free Sorting and Shuffling Reprint

Because sorting and shuffling (mixing a list of items) is so vital in most programming, we are making available a 20-page reprint booklet on Sorting, Shuffling and File Structures along with our May 1979 issue which has several articles on writing user-oriented programs and making the most of available memory space. The reprint booklet and issue are free with 12-issue or longer subscriptions.

At Creative Computing, we believe that computers can be of benefit to virtually every intelligent person in the country. We do not believe that the "Computer priesthood" should confuse and bully the public. As Ted Nelson stated in the Computer Lib Pledge, we do not treat any question as a dumb question, since there is no such thing. We are against computer terms or systems that are oppressive, insulting or unkind, and we are doing the best we can to improve or replace such terminology or systems. We are committed to doing all we can to further human understanding and make computers easy to understand, interactive wherever possible, and fun for the user. The complete Computer Lib Pledge is contained in our May 1979 issue which we are furnishing free to new subscribers.



Free reprint booklet and issue with a new subscription to Creative Computing.

Contributing editor Ted Nelson (L) is author of "Computer Lib/Dream Machines." Publisher David Ahl (R) is a pioneer in computer models, simulations and games.

Computer literacy to everyone

The Creative Computing Software Division is participating with Children's Television Workshop in an important new venture, Sesame Place. These theme parks are being designed to bring interactive computer games and simulations to young children (and their parents) and remove the mystique of computers from the youngest segment of our population. In addition, we are participating in projects with several school systems and museums to write reading comprehension and ecology simulations software. We are also involved in a major college-level computer literacy project.

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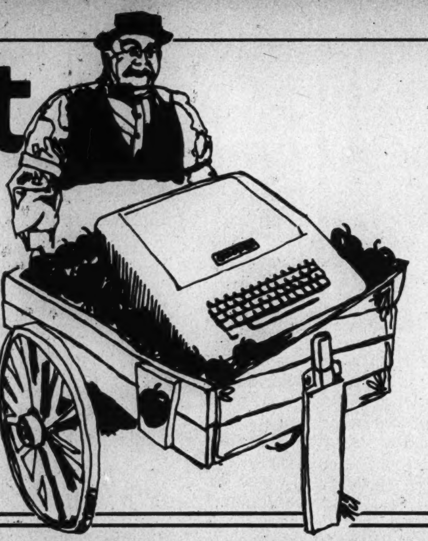
Apple~Cart



Chuck Carpenter

Correspondence is always welcome and a response will be made to those accompanied by a SASE. Send your letters to: Chuck Carpenter, 2228 Montclair Pl., Carrollton, TX 75006.

Missed last month due to a heavy work schedule and a personal illness. My work schedule may cause me to miss a column from time to time. But, keep sending the letters. I will answer them all and as timely as the complexity of the answer permits.

Input From Readers

Here's a couple of ideas from Jim Levin. The first is a clever idea to protect the system from accidental reset. Figure 1 shows a diagram of the device. The material is heavy paper such as a 3x5 index card. (I would also suggest certain types of light guage plastic). Cut the rectangle to size and fold it into a square tube 0.8 inches on a side. Tape the open edges together. Slide the tube down over the RESET key. And there you have it; RESET protection with material cost less than 1 cent and installation time under 3 minutes. Jim suggests taping the sides away from the keys to the surface of the computer.

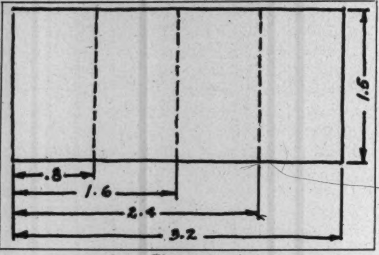


Figure 1

Jim's second idea puts a volume control on the speaker. By using an inexpensive trimmer type variable resistor, you can reduce speaker volume to any comfortable level. Connect the control as shown in Figure 2.

Mount the resistor so the screwdriver slot is accessible from one of the ventilation slots. Remember that this modification will void your warranty. Make your decision accordingly.

The volume control idea from Jim stimulated my thinking about my system. I have been using an external speaker which I connect or disconnect depending on how late at night it is. I decided to make it a little more sophisticated by hooking things up as shown in Figure 3.

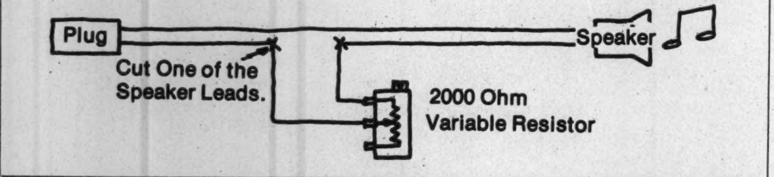


Figure 2

I mounted the switch and resistor by drilling 2¼ inch holes in the case. The jack for the external speaker is mounted on the rear apron. Now I can select either speaker with volume control. My external speaker is a Radio Shack mobile speaker. It's a 4 inch speaker in a plastic case. But it has good sound with lots of volume.

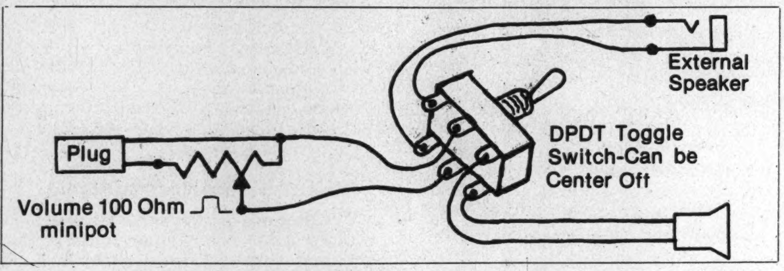


Figure 3

Again, these modifications will void your warranty.

Fred Gunther sent in another idea for program stoppers. He has solved the same problem another way. Fred suggests that you provide one of the following subroutines:

Integer Basic

```
50 PRINT"DEPRESS THE";:POKE 50,63:PRINT"RETURN";
55 POKE 50,255:INPUT"KEY TO CONTINUE.",IN$:RETURN
```

Applesoft

```
50 PRINT"DEPRESS THE";:INVERSE:PRINT"RETURN";
55 NORMAL:INPUT"KEY TO CONTINUE.";IN$:RETURN
```

Then in the main program, each time you want to pause, you need only:

```
...GOSUB 50
```

The inverse lettering for RETURN helps to make it obvious that the user presses one key rather than type in 6 letters.

More Reader Input

This great idea from Bob Sander-Cederlof will help you with some of your booting problems. The problem is that the boot program, or the so-called HELLO program, must be in either Integer Basic or Applesoft. It cannot be both at the same time. So, if you use the Applesoft version, anyone using your disk without Applesoft gets the message, "LANGUAGE NOT AVAILABLE" when the disk is booted. Or, if you use an Integer Basic boot program, the person with an Apple II Plus and no Integer Basic gets the same message.

According to Bob, there is an answer. He discovered it by reading the documentation that comes with the Apple Writer Text Editing System. The key is to remember that if the boot program is written in Applesoft, and if, furthermore, there is no Applesoft in ROM in your machine, the DOS tries to load and run an Integer Basic file with the name APPLESOFT. So, INIT your disk with an Applesoft boot program written in Integer Basic and store it on the disk under the file name "APPLESOFT."

When you boot this disk, DOS will try to boot the program named HELLO. If you have Applesoft on ROM, this will succeed, and you will be up and running. If you do not have Applesoft, DOS will attempt to load it from the disk by running the Integer Basic file named APPLESOFT which is really your other boot program.

Another RESET protector idea comes from George Norkus. This one uses an "O" ring as a stiff spring to make reset harder to push. The O ring is a National AS-108. Remove the reset key cap and slide the O ring over the plunger stem. Reinstall the key cap. Now, the hard-to-push key won't allow accidental resets. Another option, in place of the O ring, is a piece of closed cell foam. A piece about an eighth of an inch thick and a half inch in diameter will do fine. Cut an X or cross in the middle. Slide this down over the plunger as with the O ring.

I've noticed that the new Apples have a much stiffer spring on the reset key. Also, an option is now available in which you have to use CONTROL and RESET together. The new features don't appear to be available for older models. So, the ideas coming from readers will be helpful to many of us.

Feedback

In the March Apple Cart, there were several programs for loading assembly language into memory from Basic. I even went so far as to use the same zero page program in examples for page 3 use. *Can't be done!* The opcodes for instructions other than page 0 are different. The correct program for page 3 was sent to me by Thomas Giacchi. Here is his page 3 version of the Random Tones program:

Machine Language

```
 300L

0300-   FF          ???
0301-   FF          ???
0302-   AD 30 C0    LDA   $C030
0305-   88          DEY
0306-   D0 05       BNE   $030D
0308-   CE 01 03    DEC   $0301
030B-   F0 09       BEQ   $0316
030D-   CA          DEX
030E-   D0 F5       BNE   $0305
0310-   AE 00 03    LDX   $0300
0313-   4C 02 03    JMP   $0302
0316-   60          RTS
```

Pokes

```
POKE 770,173    POKE 781,202
POKE 771,48     POKE 782,208
POKE 772,192    POKE 783,245
POKE 773,136    POKE 784,174
POKE 774,208    POKE 785,0
POKE 775,5      POKE 786,3
POKE 776,206    POKE 787,76
POKE 777,1      POKE 788,2
POKE 778,3      POKE 789,3
POKE 779,240    POKE 790,96
POKE 780,9
```

In the READ...DATA routines, change the DATA values in the POKE commands. The string H$ will contain the data bytes from address $302 to $316. And the starting address should be 770, not 768. Thomas is using 768 and 769 to hold the pitch and duration values. These changes will allow the program to work in page 3 memory locations.

Software Over The Phone

Software for the stay-at-home shopper (and energy savers) is available over the phone. Several very useful and well done programs are now available from the Telephone Software Connection at (213) 329-3715. I have the phone answering program, the program to send a picture and the program to play Go Moku over the phone. I have used the answering program the most, and it makes your Apple respond like a miniature bulletin board system. My interests in electronic mail make this a most useful program.

On your first call, you will be asked to complete a short "credit application," which consists of your name, address, phone number(s), and Master Charge or Visa number. Then you will be asked to select a password to protect your account from unauthorized purchases.

Immediately after answering the questions, you will be shown a list of the programs currently available, and you are invited to select any of the free programs that are on the system. After you make your selection, it will ask you to verify that it is correct and then it will attempt to transfer you the program. If you used a "dialer" program to call the system, it will detect this and ask you to get out of that program so it won't get in the way of the transfer process. If you aren't in Applesoft it will ask you to get into it. Then sit back and watch one of the slickest program transfers you will ever see, including the saving and locking of the program onto your disk.

The program selection is unique and, as far as I know, they are not available elsewhere. One is an answering machine program that will answer a modem phone line with your name 24 hours a day. It will also let you call in from a remote terminal to get your messages and operate your system. Included are some excellent security routines to prevent "crashers" and an outgoing message capability to let you leave messages that will be automatically given to selected friends, when they call in. Other programs let you send any type of program to another computer, send a 16 line message to selected bulletin board systems, send a high-res graphics picture over the phone, and play the game Go Moku over the phone with another Apple owner.

Ed Magnin of Telephone Software Connection, says that this system's main advantages are convenience and flexibility. The convenience comes from the ease of purchasing software at anytime of day or night without stepping out of your house, and without worrying whether they have just run out of your favorite program. The flexibility is that any new programs can be on line for sale the instant they are ready, complete with documentation (included as part of the program). If updates are ever needed they can be on the system as quickly and easily as the original program.

The average program for sale takes about seven minutes (13K) to transfer, if you add three minutes for sign-on and sign-off, that means an average ten minute connection. Based on the phone rates from California to Maine, this would cost less than $4.00 during the day, $3.00

after five or $2.00 after eleven or on weekends. That is less than most postage and handling charges, and those outside of California save the 6% sales tax.

The phone transfer system will work with the D.C. Hayes modem or the Comm. card and an acoustic modem. Be sure your first free program is the dial TSC program. Then when you call back for software, you can do it automatically. TSC is adding new things all the time. By the time you read this, there will be a nice selection of programs for you to try. And, the transfer process really is fascinating.

S-C Assembler II

In the May column, I mentioned using an assembler other than the mini-assembler in the Apple II. And, for those of you with the Apple II Plus, the only way you can do any machine language assembly is with an "external" program. I have used the S-C Assembler II for a couple of years now. There are a number of assemblers on the market, but none as easy to use by the casual user. The S-C Assembler II (S-C A2) includes many useful features for creating, editing, assembling, and testing your assembly language programs. Let's take a look at some of these features:

- Similarity to Basic - S-C A2 is completely integrated with Basic routines. If you are familiar with Basic in your Apple II and its syntax, you can easily understand the S-C A2. Works on all Apple models.
- Compatible with the Apple II mini-assembler-Input format and assembled output will be familiar to users of the mini-assembler. Those of you starting on the Apple II Plus will appreciate the standardized format. Machine language is made easier and more powerful with extensions such as labels, symbolic addressing and comments.
- Line Oriented - S-C A2 uses line numbers like Basic and has complete screen editing features and capability to renumber, you can add-to, delete and change your program easily and conveniently.
- Compact Size-The tape version will easily run, with lots of working space, on a 16K machine. The DOS version, because of DOS, requires more memory; a 24K system is the minimum.
- Cassette and DOS Support-Both the tape and DOS versions support standard Apple II I/0 syntax. Also, both versions include an internal printer driver routine and/or the support of peripherals using the PR# command.

For the newcomer to the world of assembly language, the S-C A2 will provide a familiar way to start writing your own 6502 assembly language programs. Once you become more skilled, there are several S-C A2 extensions that will facilitate your program writing. For instance:

- Pseudo Opcodes-There are seven codes called assembler directives in the S-C A2. These codes allow you to define the origin (.OR), define a target address (.TA), define equates for address expressions (.EQ), define data (.DA), define ASCII strings (.AS), define HEX strings (.HS) and end the program or test segment (.EN).

There are 13 assembler commands that provide functional program development and control. The assembler is fully compatible with DOS 3.2, and all the Apple II monitor commands are usable inside S-C A2. I found using the assembler as easy to use as programming in Basic. I think you will find it enjoyable to use too. You can purchase the S-C Assembler II at many computer stores. If it is not available where you are, you can order by mail from S-C Software, P.O. Box 5537, Richardson, TX 75080. The price for the tape version is $25.00 and for the DOS version, $35.00. Both include a 40 page reference manual.

Apple II Simulators

Using the Apple II as a development system for two popular microprocessors is now possible. An 8080 and an RCA 1802 simulator by Dann McCreary will do the job. The simulators allow you to enter opcodes and data using the format of the particular computer. The simulators then interpret the hexadecimal code as though a program was being executed on the particular computer.

Included in the package are a tape and supporting documentation. The tape includes the interpreter manual, the interpreter, a sample program and a disassembler for micro's assembly language code. The documentation includes a listing of the sample program, a summary of all the instructions and commands found in the operators manual and a programmers reference card. The package is designed to run on a 16K or larger system.

To make effective use of the Apple II capabilities, Dann has created special codes for calling 6502 routines. This way you can develop your software and take advantage of Apple II features at the same time. Some of the vacant opcodes for the computer are used to include a mnemonic and corresponding opcode for 6502 calls. By using the opcode in your routines, a variety of programming options can be included.

Developing the particular code requires that you first hand assemble your program. Then, using the Apple II monitor routines, enter the HEX machine code into memory starting at address $1000. Now, call the simulator-interpreter at address $800 and execute the program using simulator commands. All the registers for the micros are displayed on the screen and complete editing and debugging commands are available. All I/0 ports, external flags and interrupts are implemented by the simulators. Once the program is written and debugged, you can implement the code on your dedicated controller.

Both packages include instructions for customizing the programs to fit your system configuration. And, both are available for $21.50 from Dann McCreary, Software Design, Box 16435, San Diego, CA 92116.

The New Apple II Reference Manual

Those of you who have only recently purchased your Apples probably got one with it. The new reference manual replaces the "Red Book." For anyone interested in learning all about the innards of the Apple, the new reference manual is the book to have. Such infinitely useful items as schematics and complete pin-out data on all connectors are provided. Tables of page zero usage for each language are included. (Shows where all the spots are not used so you can tuck a byte or two of data away.) And, all the PEEKs, POKEs and CALLs to the game paddle and other I/0 functions are tabulated for you. The differences between various revisions of Apple mother boards are discussed, and so are the features of the autostart ROM. There is much, much more, and if you didn't get the new reference manual with your Apple, it's an excellent addition to your Apple library. ☐

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Outpost: Atari

George Blank

Resources

Where do you get more help and information about your Atari? Obviously, *Creative Computing* is one source, and there are several others. If you are a beginner, the Atari Basic self-teaching guide that came with your computer will get you started. When you send in your warranty card, you will recieve the Atari 400/800 Basic Reference Manual, which is much better, and actually answers most of your questions. I had three questions when I first started programming the Atari:

1. How do you concatenate strings?
2. How do you array strings?
3. How do you obtain keyboard input without stopping the program?

Atari had given me the name of someone in the plant to call for questions, so I called and left my questions. Within hours they called back with the answer; "We don't know." The next day my preliminary reference manual arrived, and it had answers to all three questions! The answers were not easy to find, but they were there.

1. To concatenate a string variable, follow these steps:
   a. Dimension the recieving string large enough to hold the combination.
   b. Determine the length of the original string with the LEN function.
   c. Assign the string to be combined to the next location in the receiving string.

   Here is a program to do it:

```
10 DIM A$(10):DIM B$(5)
20 A$="THIS"
30 B$="+THAT"
40 A$(LEN(A$)+1)=B$
50 PRINT A$
```

2. String arrays are difficult in Atari Basic. Essentially, you have to dimension a very large string, store all other string data as substrings, and do your own bookkeeping to keep track of where each item is. The Alpanumeric Sort routine in Appendix A of the Reference manual uses this method. One advantage of Atari Basic is that there is no arbitrary limit to the size of a string, as there is in Microsoft Basic, so there is a lot of flexibility.
3. To strobe the keyboard, PEEK location 764 in memory to determine when a key is pressed. To obtain a single character from the keyboard, OPEN the keyboard as an input device and use the GET command:

```
10 X=PEEK(764):IF X<255 THEN PRINT X
20 GOTO 10
10 OPEN #1, 4, 0, "K:"
20 GET #1, A
30 PRINT CHR$(A)
```

Other sources of information include *Compute* magazine, which divides its attention between the Pet, the Atari, and the Apple. It is $9 a year, 6 issues, from *Compute*, 900 Spring Garden Street, Greensboro, NC 27403. SoftSide Publications has announced a game magazine for the Atari, to include several programs in each monthly issue. Write SoftSide: Atari, P.O. Box 68, Milford, NH 03055. The subscription rate is $15 a year.

I have since received the regular Basic Reference Manual, and it is even better than the preliminary one. One nice new feature is an excellent memory map. Some information is still not released, but I get the impression that this is because Atari is reluctant to release it in its preliminary form, not because they are trying to hide something. I know that they have been particularly helpful to friends of mine who have signed non-disclosure forms.

Tutorial Series

One excellent source of information is *Iridis*. *Iridis* was first advertised as a magazine, but now describes itself as "a series of tutorials about the Atari Personal Computer." It is sold, not by subscription, but by individual issues.

Iridis I contains four programs with explanatory articles, three columns, and an explanation of their format for printing control characters. You can purchase it either with the programs on cassette ($9.95) or on disk ($12.95).

The four programs include "Clock," a high resolution wall clock with moving hands, ticking and chimes; "Zap," where a joystick-controlled snake moves around the screen eating bits of food and growing; "Logo," which displays the *Iridis* logo in dozens of different shades, with instantaneous changes from one color to another; and "Polygons," which constructs geometric patterns.

Each program is listed, and a "behind the scenes" article following each listing explains the program in detail. These listings are very well

---

George Blank, Foster Road, Milford NH 03055

Outpost, cont'd...

done, and contain fascinating glimpses into programming techniques. For example, you can test to see if the START button is pressed by checking to see if memory location 53279 contains anything other than 7.

The three columns are "Novice Notes," with programming tips for the beginner, "Hacker's Delight,". which goes into detail about how the machine works, and "Oddments," which contains features too short to deserve an article, but too significant to be ignored.

Iridis I comes in manual format, 6 inches by 9 1/2 inches, and contains 32 pages. The print is quite small, and appears to be typeset with a small computer word processor and printer. Except for a chart on the last page showing the Atari control characters, there are no illustrations.

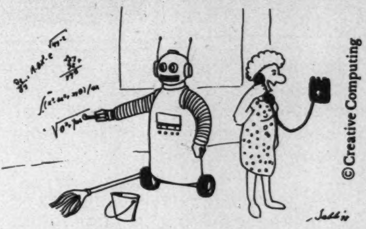
You may order *Iridis* from The Code Works, Box 550, Goleta, CA 93017

Itty Bits

As a closing feature, here is a calculator program I use frequently to balance my checkbook, do my taxes, and for any other adding machine functions. Although it is very short, it is one of my favorite programs. To clear the memory, enter the present value of the accumulator (B) as a negative number.

```
10 INPUT A : B=B+A : PRINT B : GOTO10
```

Do you have a tiny program that you have found useful? Send it in for future Itty Bits. You won't win a fortune, but you might see your name in print. □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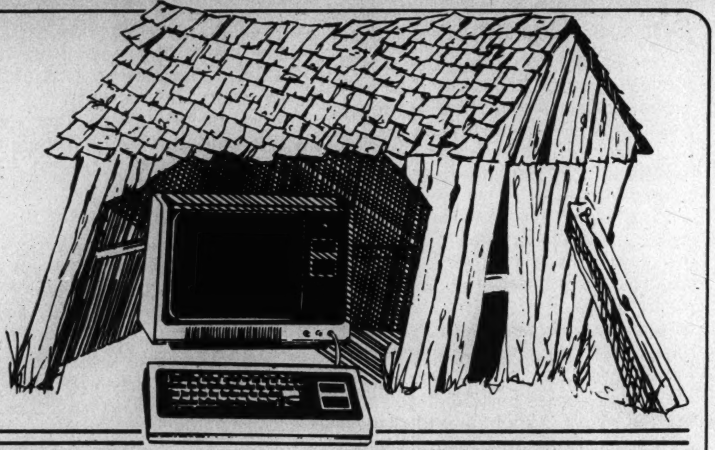
TRS-80 Strings



Stephen B. Gray

For the twentieth TRS-80 column, we unwind a CLOAD cover-art program to find out what makes it tick, check out some of the CLOAD tapes published in the last year and a half, examine the Cook Labs azimuth-check meter and two Cook programs, take a look at a checkers program by Lance Micklus and at *Creative's* Air Traffic Controller program and also at a Dungeon Explorer game, and end with a short program that produces one of the most startling displays you've ever seen, and which you're hereby challenged to predict before you RUN it.

A pair of TRS-80 monitors in one of the executive offices showed that the day's TRS-80 production up to that moment, around two in the afternoon, included 131 Level-I machines: 127 with 4K of memory, 4 with 16K.

CLOAD Cover Graphics

Now that we've looked awhile at creating graphics with a TRS-80, let's check out some of the graphics available in the world of software.

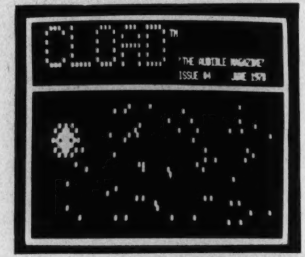
One source is the "covers" of CLOAD magazine, which is on cassette. Each issue, which provides games and practical programs, starts with a standard display of CLOAD in big letters, plus the issue's date, at the top.

The bottom two-thirds of the "cover" is reserved for a graphics display that creates a picture, over and over, until you're ready to BREAK and load the next program.

CLOAD started in March 1978, has programs for 4K Level-I on one side of the cassette, and most of the same programs for 16K Level-II on the other side.

Incidentally, several readers have told me they know for a fact that Radio Shack no longer manufactures the Level-I TRS-80. But when I visited Fort Worth a few weeks ago and was taken on a tour of the assembly plant, a pair of TRS-80 monitors in one of the executive offices showed that the day's TRS-80 production up to that moment, around two in the afternoon, included 131 Level-I machines; 127 with 4K of memory, 4 with 16K.

The June 1978 CLOAD cover-art program fills the lower part of the display with a random number of graphics blocks. Then a flickering "bomber" block scans the area, from top to bottom, left to right, wiping out each block in turn with an "explosion" the size of a quarter.



The full cover program consists of 118 lines and a total of 179 statements. Let's peel it down to the essentials.

We can easily peel off the lines that print the outlining rectangle, the words at the top of the cover, and the copyright message that appears after the bomber has emptied the screen, and before the display starts over again. That cuts the program down to 69 lines.

By eliminating the explosion graphics, the program is now 13 lines long. The explosion takes so many lines because it consists of a grid of many blocks that are SET and RESET in a blossoming pattern that fades away.

Of the remaining 13 lines, one can be peeled off to reveal the core program of 12 lines with 14 statements.

When you get down this far, by the way, it's best to print out the program, so if you remove a line and find you shouldn't have, you can easily put it back. If you don't have a printer, write down the line before you remove it, or you'll have to CLOAD the original program again and start all over.

The core program, with a CLS added at the beginning, is

```
10 CLS
20 P=RND(350)
25 IFP<10THEN20
80 FORI=1TOP
85 X=RND(112)+7
90 Y=RND(43)
95 IFY<=18THEN90
98 SET(X,Y)
100 NEXTI
110 FORX=7TO119
115 FORY=19TO43
160 SET(X,Y):RESET(X,Y)
170 NEXTY:NEXTX
```

Lines 20-25 select a random number of 10 to 350 graphics blocks. Lines 80-100 set those random blocks in a rectangular field in the bottom two-thirds of the screen, between x=7 to 119 and y=19 to 43. Lines 110-115 and 170 delineate the field for the bomber to flit through, turning on and off as it runs from top to bottom (Y=19 to 43) and left to right (X=7 to 119).

Line 160 is the key line. It turns on the flickering bomber block and, as it turns the block off, also turns off any other block that may have previously been there. In the full program, the explosion often wipes out more than the block it's centered on, because of the RESET lines in the explosion subprogram.

To add a little more flicker to the moving bomber block, line 120 can be put back in:

```
120 IF POINT(X,Y)=0 GOTO 160
```

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CIRCLE 146 ON READER SERVICE CARD

Strings, cont'd...

Can you figure you why that line adds more flicker?

We'll look at another CLOAD cover-art program again soon, thanks to the kind permission of CLOAD publisher Ralph McElroy. Many of the back issues are available, by the way, at $3.50 from CLOAD Magazine, Box 1267, Goleta, CA 93017. A year's subscription is $36, six months for $20. Volume II of the "Best of CLOAD" is $15 a copy.

When the IQ is 3, the computer takes from 2 to 4 minutes to move, and can fool you with what seems to be a poor move, but often turns out to be a trap.

CLOAD Highlights

These are some of the highlights of CLOAD tapes published since I last wrote up a few:

Reaction Test: How fast can you react to a stimulus? (Dec '78). Sketch: simulates the old Etch-A-Sketch, can also erase and store (Dec '78). Jukebox: plays any of six tunes through an AM radio (Dec '78).

Road Rally: Speedway, racing around track (Jan '79). Corporation: simulates a small company; you make decisions (Feb '79). Disassembler (Feb '79). Worm: guide the worm through the maze (Mar '79). Hustle: chase peripatetic target (Apr '79). Grapher: draws graph in polar or cartesian coordinates (June '79).

Bounce: try getting ball into pockets (Jul '79). Psycho: moving graphics display; you set parameters (Jul '79). Grand Prix: car race, with variables (Aug '79). Poke: machine-language monitor (Sep '79). Psycho-Logic: game of mathematical deduction; 19 levels of difficulty (Nov '79). Blockade: two-person real-time test of reaction time (Dec '79). Tape Test: writes test pattern on tape, checks it out, shows what volume level is best (Dec '79).

Hi Calc: four-function calculator; 1,500-digit precision (Jan '80). RAM Test (Jan '80). Monitor: similar to T-BUG (Feb '80).

My favorites among these are Psycho-Logic and Hustle. The first is the most devilishly conceived math-deduction game I've seen yet, and requires a second computer to play it above the fourth level, unless you're a math genius.

Hustle is a great challenge to your patience and maneuvering skill, as the screen fills more and more with the longer and longer tail of the snake-like trace, as you try to hit the evasive targets without hitting the walls or the trace itself, and without reversing directions.

Azimuth Check

If your Level-II TRS-80 has no problems reading program tapes you've made, but does when trying to read tapes written elsewhere, Cook Laboratories says perhaps your problem is with the azimuth of your cassette recorder's record/play (R/P) head.

The R/P head is essentially a C-shaped magnet with a very narrow gap where the magnet comes around to almost touch one end to the other. The gap looks like a thin vertical line, and the R/P head is installed with the gap as vertical as possible.

How do you check this verticality, this azimuth? One of the very few ways is to use the "Peek-80," which is the PK-80 Peak Reading Voltmeter ($49.50 from Cook Laboratories, Inc., 375 Ely Ave., Norwalk, CT 06865).

Using the op-amp PK-80 is simplicity itself. Just take the EAR plug from your cassette recorder, plug it into either of the I/O jacks on the meter, and run the supplied patchcord from the other I/O jack to the EAR jack in the recorder.

Play the "Azimuth Calibration" side of the tape, and "adjust azimuth screw for maximum meter reading," using the supplied Philips-head screwdriver.

The brief manual notes that you can "turn a cheap cassette over, and the azimuth may appear to have changed. This is not the fault of the cassette deck; it is the fault of the cassette."

Chrome tapes are recommended, and Cook Labs sells chrome tapes, from a C-10 at $3.25 to a C-60 at $5.25. These cassettes are said to be "*video*, not *audio* chrome tape." They also offer software-duplication facilities.

Cook Labs also has a free service. As the accompanying "Digital Bucket" information sheet puts it, "If the reader would like to know what the cassette-deck speed is, CSAVE any TRS program, Level-I or Level-II, short or long, or a data file, or anything — send the cassette to Annette at Cook Labs . . . with 28¢ return postage (stamps acceptable). Same-day turn-around follows, with notation on N% plus or minus; also a note on azimuth condition. Cassette returned with note; no charge."

According to a friend of mine who's the chief engineer of a radio station, and who tests hi-fi equipment for an audio magazine, and who is also becoming a personal-computer expert, azimuth isn't all that important in a TRS-80 cassette recorder. To make trouble, he says, "the azimuth would have to be so severely tilted that the machine wouldn't record anyway, because the head would probably be falling out of the deck."

He notes that the TRS-80 uses an audio recording system, not digital, and says "if the tape is good for audio, it's good for digital" in such a system. He recommends Maxell's UD, TDK's AD or SA, and Memorex's MRX^3.

Azimuth *does* make a difference in high-fidelity recording, he says, because a tilted azimuth results in the loss of high frequencies.

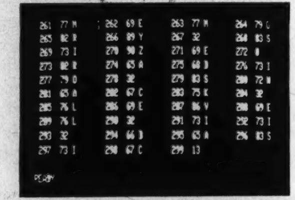
Steve Leininger, designer of the TRS-80, says that when azimuth is out of alignment, the recorded pulses tend to spread out a little wider. This is no problem if you have had the free cassette modification installed, because it has a digital one-shot in it.

As for using chrome tapes, he says the audio recording system in the TRS-80 is not set up with the correct bias for chrome tapes; and audio tapes, such as the Radio Shack "Gold" tapes, are better.

Two "convenience programs" are on the other side of the DuPont chrome-tape cassette, Peeker and RUN4.

Peeker

The three-line Peeker program displays the contents of any RAM memory locations you choose. Just enter the low and high bytes, and the screen is immediately filled with a four-up display.



```
261  77 M     262  69 E     263  77 M     264  79 O
265  82 R     266  89 Y     267  32       268  83 S
269  73 I     270  90 Z     271  69 E     272  0
273  82 R     274  65 A     275  68 D     276  73 I
277  79 O     278  32       279  83 S     280  72 H
281  65 A     282  67 C     283  75 K     284  32
285  76 L     286  69 E     287  86 V     288  69 E
289  76 L     290  32       291  73 I     292  73 I
293  32       294  66 B     295  65 A     296  83 S
297  73 I     298  67 C     299  13

READY
```

You might try adding a couple of lines to Peeker, to also print the alphanumeric equivalent of the RAM-memory contents. Then ask for the contents of locations 261 through 299. Actually, you can do that with only

```
3 FOR X=261 TO 299
4 A=PEEK(X)
5 PRINT X; A; CHR$(A),
6 NEXT
```

RUN4

The other Cook Labs program is a two-line utility that "brings string

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5. Stacking programs: permits you to stack one or more basic programs in high memory while you work on or run another program. You can call these programs down at any time to merge to the program that you are working. (limited only by the memory size of your machine).

This program sold on cassette for $29.95 and works in Level II or DOS (works under TRSDOS 2.1, 2.2, 2.3, NEWDOS 2.1 we do not have NEWDOS-80 yet to test) and comes with 13 page manual. Automatically relocates itself to not interfere with other machine language programs that you have in high memory.

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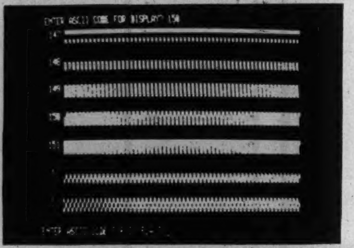
CIRCLE 182 ON READER SERVICE CARD

Strings, cont'd...

graphics of your choice, offering quick opportunity for selection." Rewritten for this column, the two lines become

```
1 CLS
4 CLEAR 59
5 INPUT "ENTER ASCII CODE FOR DISPLAY";G
6 FOR H=C-3 TO G+3
7 PRINT H; STRING$(59,H)
8 NEXT
9 GOTO 4
```

This displays a row of characters equivalent to the ASCII code, plus three rows above and three below, of the three preceding and three following ASCII-codes equivalent characters.



```
ENTER ASCII CODE FOR DISPLAY? 150
```

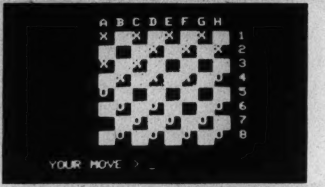
Useful, but I still prefer my version (Nov '79, p 179), "which will print a full set of graphics characters next to their ASCII codes, give you a moment to select one by number, ask for that number, and then print an allover pattern using that character, to show you what it would look like in a continuous pattern."

The Mean Checkers Machine

The latest TRS-80 game from the deft hand of Lance Micklus is The Mean Checkers Machine, which plays checkers at four skill levels. The program is written in Fortran, and runs in only 12K because several subroutines are in assembly language.

The cassette version runs on a 16K Level-II machine, and is $19.95. The disk version runs under TRSDOS, requires 32K and a single disk drive, and is $24.95. If your local computer store doesn't have The Mean Checkers Machine, you can get it from The TRS-80 Software Exchange (17 Briar Cliff Drive, Milford, NH 03055). An annotated source-code listing of the entire program may be offered at a later date, if there's enough demand for it.

If you win, the computer says: SHUCKS!!! I LOST. But to win, you have to eliminate all your opponent's pieces from the board. If you place him (the computer) in a position where he can't make any legal moves, a stalemate results, and no matter how far ahead you are, the game ends in a draw. This can be exasperating, especially if you have eight kings and the computer is down to one piece. It can happen.



```
YOUR MOVE > _
```

The checkerboard is labeled A to H across the tops of the columns, and 1 to 8 down the rows. My first move was B6-A5, and the display changed to reflect that move as soon as I pressed ENTER. The computer considers its move, announces in print what move it intends to make, flashes on and off the X representing the piece it will move, and then moves it.

During the first games I played, the computer took from 12 to 28 seconds to decide what move to make. The manual says the maximum is 40 seconds. That's at an IQ of 2, the level at which the computer normally plays. You can change the IQ anytime it's your turn. At an IQ of 1, the computer plays a novice-level game, and you can beat it unless you're six years old and just learning. The computer's average move time is about 5 seconds at an IQ of 1.

At an IQ of 2, the computer plays an average game. It makes mistakes just as you might, unless you're an expert. You can beat the computer if you're careful. When the IQ is 3, the computer takes from 2 to 4 minutes to move, and can fool you with what seems to be a poor move, but often turns out to be a trap.

At an IQ of 4, the computer takes 10 to 20 minutes to find a move. This is the computer's championship level, and is almost impossible to beat unless you're an expert.

If you haven't got time to finish a long game, or if you'd like to go back and play a game in different ways from a particular point in the game, you can SAVE a game on tape or disk, to record the current checkerboard. Then you can call it up at any later time, and play from that point on.

If your move is illegal, the computer displays *** INPUT ERROR *** and again prompts you for a move.

When you're ready to give up, type QUIT instead of your move, and the computer resets the board. If you want the computer to go first, type UMOV instead of entering a move. Although UMOV works anytime during a game, the manual notes that "it is only legal at the beginning of a game. The computer assumes you are an honest player." (No, you can't make the computer play against itself.)

The Mean Checkers Machine is Micklus' third checkers-playing game. He wrote the first in Sigma 6 Basic, based on the checkers program in *Creative Computing's* "101 Basic Computer Games" (p 73), with added improvements.

Later Micklus transferred it to the TRS-80 in Level-I Basic, and then converted it to Level-II Basic. But still it didn't play what Micklus considered a very good checkers game.

So, borrowing the principles, he rewrote the game completely, using a one-move look-ahead. The game was better but much too slow. So he bought Microsoft's Fortran package, which he found to be "the perfect language" for his use. According to the manual, "Fortran compiles into machine-language code which executes many times faster than Basic, yet offers the kind of powerful high-level instructions and array-handling found in Basic."

To make the program run on a 16K Level-II machine, some of the subroutines were written in assembly language, using Microsoft's M80 compiler. Making the jumps optional also helped keep the game in 12K. Micklus says he may someday write a checkers game in which you *have* to jump.

If you don't have a multitrack mind, an unflappable disposition and the ability to think clearly in the face of impending air disaster, don't buy Air Traffic Controller.

In the display, the squares measure about 3/8 by 3/8 inch, x is used for each of the computer's pieces, and O for each of yours. These, and all the other letters and numbers on the screen, are double-width. When you get to the king row, your O becomes O*; likewise the computer's piece becomes X*.

Just in case you're not charmed by such simplicity, the manual notes that the screen-display format "was chosen because it clearly displays the board, even though it is less dazzling than other board-type games. The author feels there aren't enough computer games small children can play. This display is less confusing to children, even if it doesn't impress daddy's computer friends." So there!

The computer plays on the offense, with an aggressive game; it isn't afraid to go after you. Toward the end of the game, it has been programmed to attack, which is why Micklus called it The Mean Checkers Machine.

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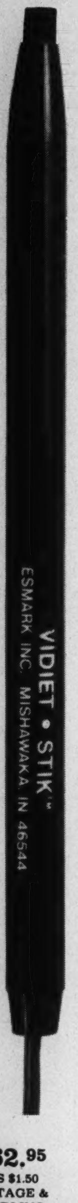
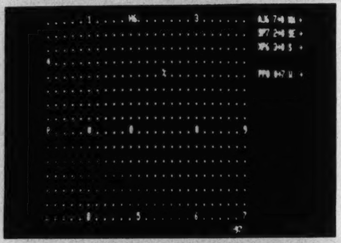


Strings, cont'd...

Air Traffic Controller

If you don't have a multi-track mind, an unflappable disposition and the ability to think clearly in the face of impending air disaster, don't buy Air Traffic Controller, a machine-language simulation for the Level-II 16K TRS-80, from *Creative Computing*.

But if you think you can keep calm while 26 aircraft, both jet and prop, are heading into the airspace you control, and you can either pass them through your area safely or land them properly at the two airports, then you might consider sending in $7.95 (plus $1 for shipping) for this "absorbing and stimulating simulation," as the *Creative* ads put it. The simulation was written by David Mannering, a professional air traffic controller.



Even before you load this game, you've got to learn many rules, all about the aircraft speeds, altitudes, headings, fuel, etc.; requirements such as "all active aircraft must be separated by at least 3 miles or at least 1,000 feet of altitude at all times"; instructions on how to guide aircraft; and enough more to thoroughly confuse you until you've read it all several times.

To quote from the instructions, "To begin the game, you select the number of minutes you wish to play (between 16 and 99). This is the amount of time you have to process all twenty-six aircraft." Select 16, and the game will be over within one minute, due to immediately impending disaster, unless you're a controller and have memorized all the rules. As the instructions put it, "The record time for successfully completing this simulation stands at 21, which is truly outstanding. Novice Air Traffic Controllers should try a time of 65 or higher to start."

This is not a game for the faint-hearted, the indecisive, or those who prefer batch-processing instead of real-time operations. Play it at your own risk.

Dungeon Explorer

This Level-II 16K single-player game was written by Matthew D. Kiriazis, and is $8.50 postpaid from Software Exchange (2681 Peterboro, W. Bloomfield, MI 48033). (This is not The Software Exchange, of Milford, NH.)

As an adventure game, Dungeon Explorer is rather limited. The dungeon is small, so you can't go very far without having to backtrack. There are only three rooms in the dungeon: an "empty and bloody chamber," a room with a chest, and a room with a flagon; all the rest is corridors and intersections.

Eight monsters are supposed to be in the dungeon, but only the "nasty orc" and the "hungry ghoul" showed up while I was playing. Actually, "as the characters progress, they will face stronger and stronger monsters," but I couldn't get interested enough to play that long.

During a run, your character often keeps running into the same problems again and again, finding the chest or the potion over and over.

During a RUN, your "character" often keeps running into the same problems again and again, finding the chest or the portion over and over. If he declines to take the stairway out of the dungeon, he meets a nasty orc, and if he decides to run rather than fight, he comes upon the stairway, again and again.

Your character can be killed by the orc or ghoul, but he's almost always "raised back to life" and you're told to "be more careful." Now and then he can be killed permanently, and a gravestone is drawn.

Theoretically, the challenge is to avoid getting your character killed, and to advance him up "through the ranks" from recruit to super-hero, but the game is too limited in scope, too poorly written, and too boring to offer any real challenge.

Short Program #11

Jim Raden of Maumee, Ohio, sent in a short program that creates a startling display you might not be able to predict from the program itself:

```
10 FOR A%=155 TO 1 STEP -1
20  FOR B%=15360 TO 16383 STEP A%
30   POKE B%, 191
40  NEXT B%
50  CLS
60 NEXT A%
70 GOTO 10
```

Jim's letter says, "This one isn't useful at all, except maybe for some type of game. I'll let you try it out yourself to see what it does." □

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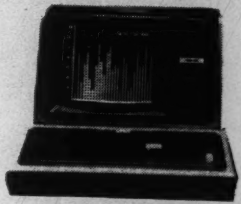

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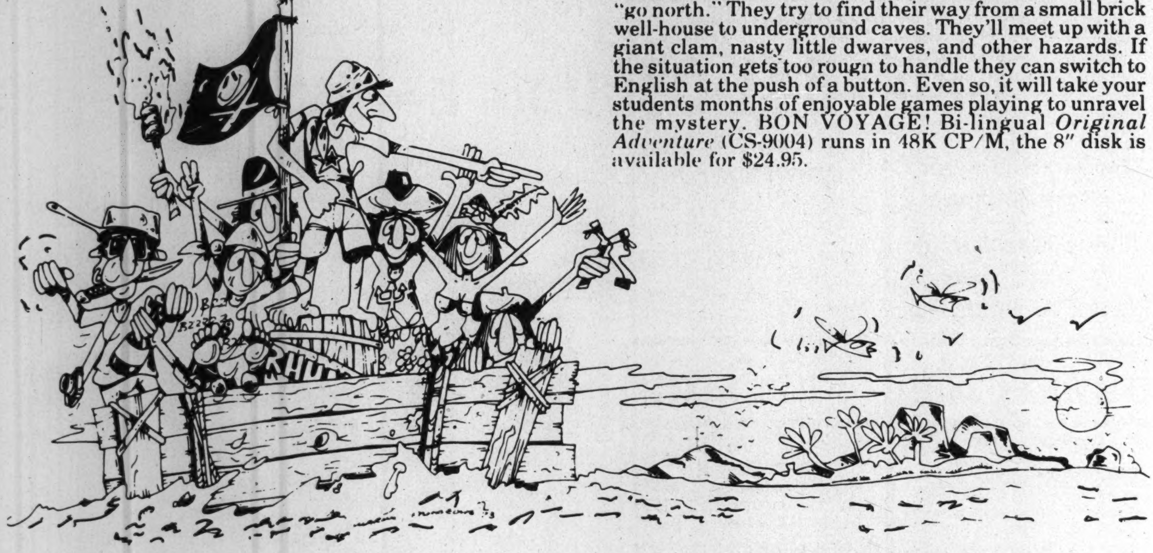
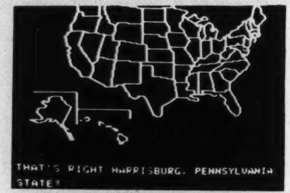


Creative Computing offers a wide variety of uncomplicated user-oriented educational programs. **Study Made Easy** for the PET (CS-1202) will create study drill tapes for any subject automatically. The computer guides you, step by step, through the entry of questions and multiple choice answers. The package includes three prepared drills. From U.S. Presidents to Lacrosse rules, the versatile programs of **Study Made Easy** will create study drills for you automatically. It's well worth the price of $14.95.

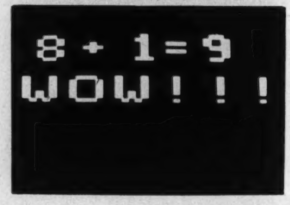
CAI Programs offers a diverse group of study aids. **U.S. Maps** uses high resolution graphics to help students learn the states and their capitols. **Spelling** increases its pace as you progress. **Math Drill and Add with Carry** will help you with mathematics basics at your skill level. The **Know Yourself** package (CS-4301) helps you investigate society's effects on your behavior, how your life style affects your life expectancy, and how your attitudes are affected by society's concept of sex roles. **CAI Programs** and **Know Yourself** are available individually on cassette for $7.95 each or on one disk (CS-4503) for only $14.95. Cassette versions will run in 16K and the disk requires 32K. These are for the Apple II.

Computer Assisted Instruction Programs



```
THAT'S RIGHT HARRISBURG, PENNSYLVANIA
STATE?
```

U.S. Map



```
8 + 1=9
WOW!!!
```

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The series (which is based on models developed by The Huntington Two Computer Project) exposes students to problem solving in real world situations. **Ecology Simulations-1** (CS-3201) explores methods of population management. Students can cooperate to save the Wild West bison from extinction in **Buffalo.** The comprehensive introduction to modeling concepts is completed in **Pop, Sterl,** and **Tag**.

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The series is designed for the 16K TRS-80 Level II and is attractively packaged in a vinyl binder. Included is a study guide which relates the material to current controversies, stimulates classroom discussion, and provides sample exercises. The series is also available on disk: **Ecology Simulations-1** (CS-3501), **Ecology Simulations-2**(CS-3502),and **Social and Economic Simulations** (CS-3508). At a modest $24.95 each, with quantity discounts available, the series becomes an affordable necessity.

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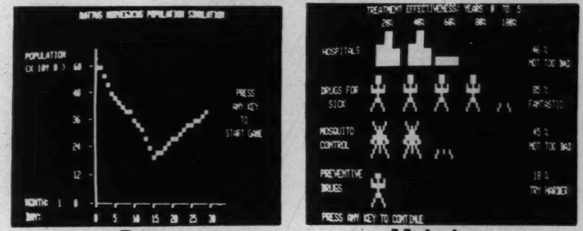
"The manual is extremely well done. It provides necessary background information on each program and encourages the student to think about the social aspects of each program rather than just the mathematical processes."

**80 Software Critique on
Ecology Simulations-1
Jan-March 1980**

Ecology Simulations-2



Rats **Malaria**

Apple Gradebook (CS-4506) brings the speed and accuracy of the computer to the teacher's traditional grading and record-keeping procedures. Gradebook stores and maintains all student records on disk. The package includes ten interlocking programs which lead you step by step, through setting up a class file and storing it on disk. These invaluable programs summarize the state of the class as a whole and then let you check on the progress of any individual. Apple Gradebook runs in 32K on Apple II and costs only $24.95.

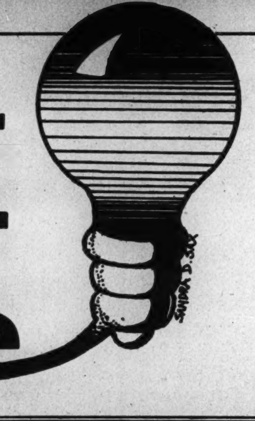
IQ Test conducts a reliable intelligence test for ages 10 and over. A sophisticated machine language program does the scoring and makes cheating almost impossible. The test consists of 60 graphically presented questions. Only $14.95 on cassette for the 16K TRS-80.

Creative Computing Software offers the educator, small businessman and home user outstanding applications programs at modest prices. A FREE **Sensational Software Catalog** of over 400 programs, on 70 tapes and disks, is available upon request. **Sensational Software** has the programs educators need to make microcomputers in the classroom worthwhile... children can compose poetry, learn the role of an air traffic controller, or simply make music with software from **Creative Computing.**

Sensational Software should be available at your local computer store. If your favorite retailer does not stock the software you need, have him call our retail marketing department at the number below. Or you can order directly from Creative Computing Software, Dept. AGII, P.O. Box 789-M, Morristown, NJ 07960. Visa, MasterCharge, or American Express are also welcome. For faster service, call in your bank order toll free to 800-631-8112. In NJ call 201-540-0445.

CIRCLE 300 ON READER SERVICE CARD

Compleat Computer Catalogue



APPLE III

The Apple III is a fully integrated computer system with built-in disk drive, up to 128K bytes of memory, color and black and white video, and can accomodate a wide range of peripheral devices.

Two new application packages are offered for use on the Apple III.

The Information Analyst software may be used in planning, forecasting, modelling, pricing and costing, scheduling and budgeting.

The Word Processor can be used for preparing memos, letters, long documents and papers.

Apple III prices range from $4,340 to $7,800.

First Two Packages

The Information Analyst consists of an Apple III with 96K bytes of random access memory. It comes with a built-in 5 1/4" floppy disk drive, an integrated keyboard with a 13-key numeric keypad, two built-in printer interfaces and a 12" black-and-white video monitor. Its software includes Apple's Sophisticated Operating System as well as management-oriented tools such as VisiCalc III, Mail List Manager and Apple Business Basic for $4,340.

The Word Processor system consists of an Apple III with 96K bytes of memory, integrated keyboard, printer interfaces and a 12" black-and-white monitor, and it comes with two disk drives—one built-in and one external. The disk drives provide the capacity to store about sixty pages of text per removable floppy diskette.

It comes with a choice of printers: either an Apple Silentype draft-quality thermal printer, ($5,330) or a letter-quality, daisy-wheel printer ($7,800). Software for the Word Processor includes Apple's SOS operating system, the word processing application software and a training course.

Options for the two systems packages include up to 32K bytes of additional RAM memory, bringing the maximum to 128K bytes total; additional 5 1/4" floppy disk drives, to a maximum of four per system; either the Silentype or a letter-quality printer; the use of a standard NTSC color video monitor, an RGB color monitor, or even a standard TV set; input/output cards for interfacing other peripheral devices; and a vinyl carrying case.

The Apple III has emulation capability which lets users run programs developed for the Apple II. It uses an 80-character by 24-line upper/lower case display and has four cursor keys for single keystroke cursor movement.

The Apple III offers a built-in disk controller for handling up to four floppy disk drives. One disk is integrated in the computer and up to three additional may be ordered as options.

An integrated clock/calendar can automatically date and time-stamp files to keep track of updates. The unit has a heavy-duty switching power supply that permits it to handle more peripherals. The reset key is located behind the main keyboard area to prevent accidental system reset. And the entire unit has been designed to comply with new FCC standards on radiated interference.

Many New Features

Many of the benefits of the Apple III are made possible by a new Apple-designed central processor. It features a superset of the 6502 instruction set, relocatable base page register, relocatable stack, and 128K byte address range.

Peripheral devices request machine attention by interrupting the CPU (which optimizes speed), or the CPU may poll peripherals to see which need attention, minimizing the software required for peripheral control.

The new computer has a built-in, 6-bit, digital-to-analog (d/a) converter which gives high-quality sound for voice or music generation.

Graphics capabilities provide flexible color graphic data handling on the monitor screen, including color text foreground and background modes that are useful for highlighting as well as for high-resolution plotting and graphing.

Two Apple keys permit "soft" or program-defined functions, so commands can be executed with a single keystroke. An alpha-lock key shifts alphabetical keys (but not numbers or symbols) into their upper case mode for compatibility with the Basic programming language and the terminal requirements of other computers. All keys have a hold-down, auto-repeat feature.

Sophisticated Operating System

The Sophisticated Operating System (SOS) ties together the hardware and software features of the Apple III while isolating users from details of system operation. It is the foundation upon which other software is built.

There are four elements to SOS: a file system, a device module, an event management interface, and a memory management system. The file system is byte-oriented and interrupt-driven, and controls storage elements of the Apple III. The device module handles both block-oriented devices (such as disk memories), and character-oriented devices (such as keyboards). The event manager associates interrupts with the activities of an outside source. The memory manager programs to run anywhere there is sufficient memory, thus making memory management transparent to the operator.

Apple Computer Inc., 10260 Bandley Drive, Cupertino, CA 95014, (408) 996-1010.

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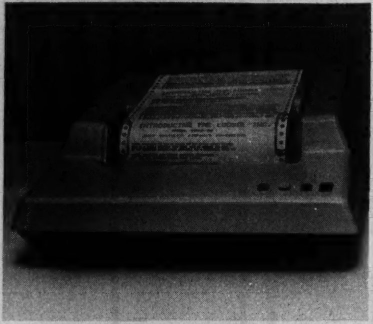
TERMINALS & I/O

IMPACT PRINTER



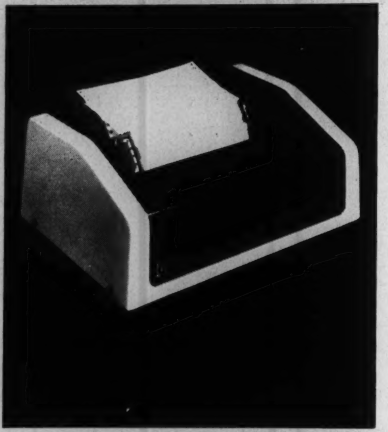
Coosol announces a low cost 88-column tractor feed dot matrix impact printer available in kit or assembled.

Primary features include: microprocessor controlled and programmable with 32 system level commands, graphics, 96 ASCII characters with upper and lower case, print with 9 software selectable sizes from 5 x 7 to 10 x 7 and 10 x 14 character fonts, standard parallel and serial interface, baudrate selectable from 110 to 9600 baud, and adjustable tractor width for paper size selection. Kits, $445; assembled, $485.

Coosol Inc., 1585-200 Adams Ave., Costa Mesa, CA 92626. (714) 545-2216.

CIRCLE 226 ON READER SERVICE CARD

VECTOR GRAPHIC PRINTER



A low-cost dot matrix printer has been introduced byVector Graphic, Inc.

In addition to its speed and high level of graphic capability, the Vector Graphic MP features quiet operation and a 5 x 7 dot matrix software driven printhead.

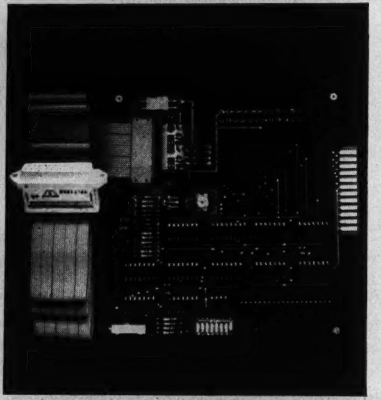
Base price of the printer is under $1,000.

Vector Graphic, Inc., 31364 Via Colias, Westlake Village, CA 91361. (213) 991-2302.

CIRCLE 227 ON READER SERVICE CARD

PRINTER INTERFACE FOR PET

TNW Corporation announces the TNW-1000, a printer interface for the Commodore PET/CBM which provides an output-only serial port to interface to current-loop as well as standard RS-232 printers and other devices.

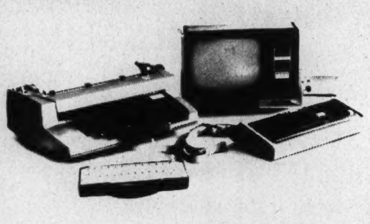


The user can set the TNW-1000's baud rate over the range from 110 to 9600 bits per second, and can switch select automatic conversion from PET to ASCII character sets for either new or old style PET, data word length and parity (8 bit words without parity or 7 bit words with even or odd parity), and IEEE bus address. $219

TNW Corporation, 3351 Hancock St., San Diego, CA 92110. (714) 225-1040

CIRCLE 228 ON READER SERVICE CARD

COMPUTER/TYPEWRITER INTERFACE



A typewriter interface designed to generate hard copy directly from a computer through any electric typewriter with powered carriage return has been announced by Rochester Data, Inc.

The I/0 Pak consists of an array of coils positioned in the same pattern as the typewriter's keyboard which fits directly over the keyboard.

Rochester Data provides interfaces and software for the TRS-80 Level I and II, Apple II and a 6 bit parallel interface for general operation with other computers. The basic I/0 Pak retails for $469. The interface board and power supply are $145.

Rochester Data, Inc., 3100 Monroe Ave., Rochester, NY 14618.

CIRCLE 229 ON READER SERVICE CARD

PERIPHERALS

Z-80 SOFTCARD FOR APPLE

Microsoft Consumer Products announces the Z-80 SoftCard, a plug-in processor for the Apple II that allows the Apple to run software written for Z-80 based computers.

In addition to the plug-in card, the SoftCard package includes the CP/M operating system from Digital Research and Microsoft Disk Basic, ready to run on the Apple II.

It allows the user to use either the Apple's 6502 processor or the Z-80 processor as needed to run a program. A command is used to switch between the two processors.

The Z-80 SoftCard will run on all configurations of the Apple from the standard Apple II to the Apple II Plus with Language Card. No hardware or software modifications of any kind are required to install the SoftCard. $349.

Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004. (206) 454-1315.

CIRCLE 230 ON READER SERVICE CARD

HOME CONTROL FOR TRS-80

Popular Computing, Incorporated announces a computer controlled Lighting and Appliance Control System for the TRS-80.

The system is a modified version of the BSR X-10 Home Control System which allows the TRS-80 to control lights and appliances throughout a home or office. Command signals are transmitted over existing house wiring. $99.95.

Popular Computing, Inc., P.O. Box 16875, Ft. Lauderdale, FL 33318.

CIRCLE 231 ON READER SERVICE CARD

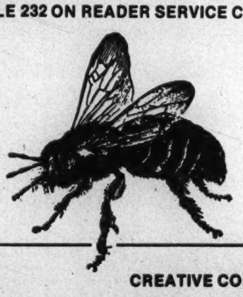
FLOATING POINT PROCESSOR BOARD FOR APPLE

Increased computational speed is now available for the APPLE II.

The Computer Station Am9511 Fast Floating Point Processor Board plugs directly into the Apple II and relieves it of the task of doing transcendental functions in software by using a special version of the standard floating point Basic called Applefast which allows the user to run existing programs with no modification.

Computer Station, 12 Crossroads, Granite City, IL 62040. (618) 452-1860.

CIRCLE 232 ON READER SERVICE CARD



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Dual Eight Inch Floppy Disk Drives.

Complete with power supply and all necessary cabling. Operates with single or double density controllers for up to 1 megabyte disk storage.

6400 bits-per-inch. 48 tracks-per-inch. 7msec. track-to-track access time. 500,000 bit-per-second transfer. Beige cabinet, 5″ x 17″ x 20¼″.

Don't look now, but I think there's a wolf crying.

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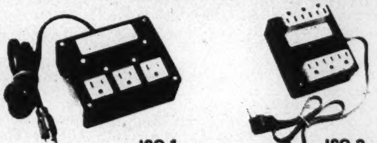
DISK DRIVE WOES? PRINTER INTERACTION? MEMORY LOSS? ERRATIC OPERATION? DON'T BLAME THE SOFTWARE!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Power Line Spikes, Surges & Hash could be the culprit! Floppies, printers, memory & processor often interact! Our unique ISOLATORS eliminate equipment interaction AND curb damaging Power Line Spikes, Surges and Hash.

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NEWDOS/80

Powerful Disk Operating System for the TRS-80® designed for the sophisticated user and professional programmer.

NEWDOS/80 is not meant to replace the present version of NEWDOS 2.1 which satisfies most users, but is a carefully planned upward enhancement.

- New BASIC Commands with variable record lengths up to 4095.
- Mix or match drives. 35, 40, 77TK .
- Security boot-up for BASIC or machine code applicaton programs.
- Improved editing commands.
- Enhanced RENUMBER that allows relocation.
- Device handling for routing to display and printer simultaneously.
- CDE function; striking of C, D, and E keys allows user to enter a mini-DOS.
- Compatible with NEWDOS and TRSDOS 2.3.
- Superzap 3.0 and 2.1 utilities.

LIMITED UPGRADE OFFER **$149**

NEWDOS owners up-grade to NEWDOS/80. Contact Apparat or MTI for information.

NEW DOS FOR APPLE® "APEX"

The complete APEX package with operating system, assembler, editor and user manuals. The package also includes a complete set of utilities to maintain files on single or multiple drive systems. (Specify 5 inch Apple disk or 8 inch disk.) **$99**

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XPLO	$59
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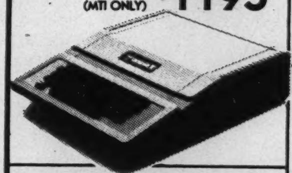
FREE MTI MEMORY UPGRADE KIT TO 48K WITH PURCHASE OF APPLE II 16K

(MTI ONLY) **$1195**



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TRS-80® SOFTWARE

NEW DOS+ 35 track	$99
AJA Word Processor	$89
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MOD I "8" DISK SYSTEM

- One SA800R DOS and Cable
- 2 Drive Chassis and Power Supply

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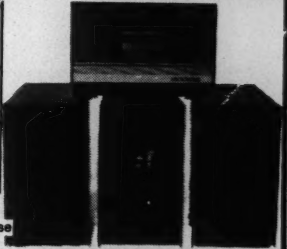

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- Interface 32K
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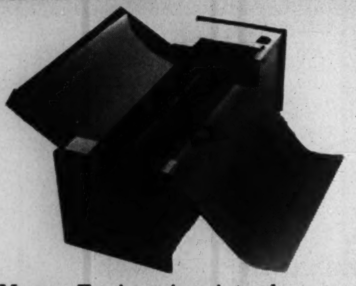
CIRCLE 181 ON READER SERVICE CARD

DIGITAL PLOTTER



Mauro Engineering introduces a multi-format digital plotter.

The MP-250 PROAC pen plotter uses standard 8½"x11" or 11"x17" paper. It plots at speeds to 2.5 inches per second with .005 inch resolution.

The standard machine uses one parallel output port and comes with full vector driver software for 8080, 6502, and 6800. Interfaces are available for TRS-80, Apple, and serial data ports $650

Mauro Engineering, Route 1, Box 133, Mt. Shasta, CA 96067. (916) 926-4406.

CIRCLE 233 ON READER SERVICE CARD

HOME CONTROLLER FOR APPLE

Soft-Sonic is a collection of programs for home control for use with the Apple computer and a BSR Ultrasonic System 10-X. The package includes transducer hardware, interface cable, and software on diskette.

The provided programs allow for control of lighting, appliances, etc., through user defined timed sequences (Applesoft) or by voice command using Hueristics Speech Lab (Integer Basic). $39.95.

B.A.C.E., P.O. Box 52785, Atlanta, GA 30355.

CIRCLE 234 ON READER SERVICE CARD

MUSIC SYNTHESIZER FOR H-8

Heath Company, has introduced a music synthesizer system for the Heathkit H-8 Computer. The HA-8-2 Music Synthesizer System includes a circuit board, which plugs directly into the bus of the computer, and the necessary system software, supplied on a standard 5¼" floppy disk.

The synthesizer board, which connects directly to any stereo system with the two shielded cables included, produces an excellent 27.5-6,600 Hz fundamental frequency response with up to 9 harmonics. $159.

Heath Company, Dept. 350-290, Benton Harbor, MI 49022.

CIRCLE 235 ON READER SERVICE CARD

MUSIC FOR TRS-80

The Music Box

Newtech Computer Systems introduces the Music Box, a complete hardware/software tool that enables the user to produce music and sound effects on a TRS-80.

It plays up to four notes at a time with a seven octave range.

The Music Box plugs directly into the TRS-80 keyboard or the Expansion Interface Bus Extension. It includes a volume control, a 400 milliwatt power amp, and phono jack for connection to an external speaker. Software is supplied on Level II cassette. It requlires a 32K RAM. $249.

Newtech Computer Systems, Inc., 230 Clinton St., Brooklyn, NY 11201. (212) 625-6220.

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VDS-IIMDD	Mainframe above with 2 Double-Sided 8" floppies, double-density interface, CP/M , Tarbell BASIC	2999.00
MEM-32K-ASM	32K fully-buffered static memory A&T	725.00
MEM-16K-ASM	16K fully-buffered static memory A&T	440.00
MEM-0K-ASM	Fully-buffered static board without memory IC's	240.00
CI-KIT	1500 baud bi-phase Cassette Interface Kit	120.00
CI-ASM	1500 baud bi-phase Cassette Interface A&T	175.00
FDI-KIT	Universal Single-Density Floppy Interface Kit	225.00
FDI-ASM	Universal Single-Density Floppy Interface A&T	325.00
DD-ASM	Double-Density DMA Floppy Disk Interface A&T	495.00

TARBELL HAS HIGH-QUALITY 8080/Z80 SOFTWARE

Part No.	Description	Price
CPM-1.4	Floppy Disk Operating System for our interfaces	100.00
CPM-2.0	Extended Version of above Operating System	150.00
MPM	Multi-User Version of above Operating System	400.00
TBAS-CAS	Tarbell Cassette BASIC (uses 24k)	72.00
TBAS-DSK	Tarbell Disk BASIC (uses 24k)	72.00
SPLR	KLH Systems Spooler for CP/M 1.4 on disk	70.00
FAST	Screen-Oriented Editor/Assembler for CP/M	100.00
TELE-COM	Telecommunications Support System	195.00
POLYVUE	Screen-Oriented CP/M Editor	135.00
PASCAL/MT	Meta-Tech Pascal Compiler for CP/M	99.95

Prices are subject to change without notice.
CP/M is a registered trademark of Digital Research.

Tarbell Electronics
950 Dovlen Place, Suite B
Carson, California 90746
(213) 538-4251 (213) 538-2254

CIRCLE 205 ON READER SERVICE CARD

DIRECT CONNECT MODEM FOR TRS-80

Emtrol Systems, Inc. has introduced Lynx, a new direct connect telephone modem designed for the TRS-80 microcomputer.

Lynx comprises a total telephone linkage system in one package, eliminating the need for a separate expansion interface, interface board, telephone coupler and communications software.

It connects directly with the TRS-80 keyboard and the telephone line and includes originate and answer capability $239.95.

Emtrol Systems, Inc., 1262 Loop Rd., Lancaster, PA 17604.

CIRCLE 236 ON READER SERVICE CARD

HI-RES GRAPHICS FOR TRS-80

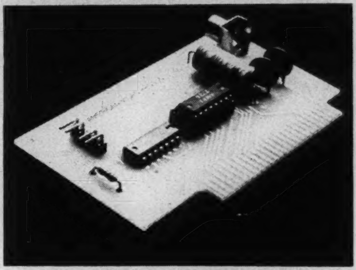
The 80-Grafix Board from Programma International offers high resolution screen capability for the TRS-80.

80-Grafix provides an effective screen of 384x192 plus lower case characters.

Programma International, Inc., 3400 Wilshire Blvd., Los Angeles, CA 90010. (213) 384-0579.

CIRCLE 237 ON READER SERVICE CARD

APPLE MUSIC SYNTHESIZER



American Micro Products, Inc. has announced a music synthesizer designed to plug into any 48K Apple computer using Applesoft Basic.

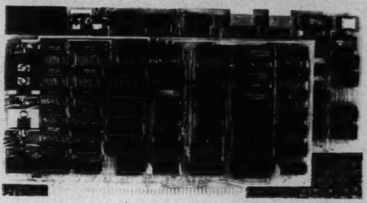
The "Juke Box" produces three simultaneous voices and one channel of white noise.

Pitch, rhythm, tempo, attenuation and envelope, can be selected and controlled for each voice independently from the other channels. It has a five octave range starting at 55 Hz to 1760 Hz. Each card has an on-board amplifier capable of directly driving an eight ohm speaker. $129.95.

American Micro Products, Inc., 705 N. Bowser, MS 107, Richardson, TX 75080. (214) 238-1815.

CIRCLE 238 ON READER SERVICE CARD

S-100 DIGITAL SYNTHESIZER



An S-100 based digital synthesizer has been developed by Casheab. The device consists of a synthesizer card and a controller card.

The synthesizer card is responsible for generating the music waveforms. All parameters are loaded into the synthesizer from the host processor, which has control over frequency, waveform, amplitude, and frequency modulation of each channel.

The controller card controls the synthesizer card, summing the channel waveforms and handling the digital-to-analog conversion.

The CP/M compatible floppy disk includes a waveform creation program, a score compiling program and a play program. $1095.

Casheab, 5737 Avenida Sanchez, San Diego, CA 92124. (714) 277-2547.

CIRCLE 239 ON READER SERVICE CARD

TV PROJECTOR KIT
Only $17.95

Imagine playing computer games or watching TV shows on a giant 5′ x 6′ screen. Picture quality is as good as giant screen TV's costing over $1500. The projector is easily built in an hour using inexpensive materials. No modification is needed to your TV. The image is enlarged up to 15 times on the wall or a movie screen. A precision lens and illustrated plans are included. No special tools are needed. The projector is guaranteed to please you or return the kit for a full refund. To order, write "PROJECTOR KIT" on a piece of paper and send it with $17.95 to:

WDB COMPUTER PRODUCTS
520 Second Street
Graham, Texas 76046

CIRCLE 199 ON READER SERVICE CARD

What you 'C' is what you get!

C Compiler for CP/M*

New, and available now! An easily affordable compiler incorporating most of the features of the full C language.

BD SOFTWARE

System requirements: CP/M and at least 24K of RAM
Variable Types: char, int, unsigned
Composite Types: arrays, structures, unions
Pointers: to variables, structures, unions and functions
Features: is a structured language, all functions (Programs) recursive; more powerful expression operators than any other von Neumann type language; allows free-formatted source; close enough to UNIX** C to make conversions feasible.
Speed: On 2 MHz 8080, the statement
for (i = 1; i < 30000; i++) x = 5;
takes about 4 seconds to execute.
Package contains: compiler, linker, library manager; standard function library; sample source files include games, a terminal emulator with disk I/O plus the source for many standard library functions; BDS C User's Guide; Book—*The C Programming Language* by Dennis Ritchie and Brian Kernighan of Bell Labs. ***Price: $125***

Recipient of the Computer Lib Seal of Approval **Manual Alone $20**

*CP/M is a trademark of Digital Research Corp.
**UNIX is a trademark of Bell Laboratories

Prices reflect distribution on 8" single density diskettes. If a format is requested which requires additional diskettes, a surcharge of $8. per additional diskette will be added

Lifeboat Associates
2248 Broadway, New York, N.Y. 10024 (212) 580-0082 Telex 220501

CIRCLE 160 ON READER SERVICE CARD

CORVUS MULTIPLEXER

A multiplexer has been announced by Corvus which can transform two to 64 personal computers into an interactive multi-user network sharing high speed access to up to 40 million bytes of Corvus hard disk capacity.

Called the Constellation, it is of particular interest for the many business and educational applications now limited to one dedicated computer and a small data base. In addition to sharing open or secured access to the large Corvus data base, computers in a Constellation network can share peripherals, such as a common printer, and communicate in a fully interactive mode.

The Constellation is compatible with the Apple, TRS-80 Models I and II, S-100 Bus, Altos, and LSI-11.

Price of the multiplexer is $750. Interfaces for the computers in the network are $235 each.

Corvus Systems, 2029 O'Toole Ave., San Jose, CA 95131. (408) 946-7700.

CIRCLE 240 ON READER SERVICE CARD

COMPUTERS

MODULAR S-100 SYSTEM

CSSN Inc. announces its System 1000 family of microcomputers: a modular, bus-oriented line of systems organized around the IEEE S-100 Standard bus.

The S/1000 includes a 4Mhz Z80A processor, 64K RAM, 8" Winchester-technology hard disk, cartridge tape data backup, a variety of I/O devices and other peripherals, a choice of hardware options, and expansion capability to 16-bit processors.

Operating systems for the S/1000 include Digital Research CP/M 2.0 and CSSN PDOS, a literal superset of CP/M 1.4. Software compatible with these operating systems includes languages such as Basic, Pascal, Cobol, Fortran, and C; business and financial packages; database management systems and word processors.

CSSN Inc., 120 Boylston St., 4th Floor, Boston, MA 02116. (617) 482-2343.

CIRCLE 241 ON READER SERVICE CARD

SMALL BUSINESS SYSTEM

The Microstar system is designed as a multi-user, multi-language microcomputer. The package consists of a single-board computer with 64K bytes of main memory, and 2.4 megabytes on two 8" floppy discs.

The prime operating system is STARDOS (Basic) supporting indexed sequential files, direct files, and sequential files. CP/M is also supplied with the system, and will operate with Northstar Basic, Microsoft Basic, and all associated machine languages.

The system will allow two simultaneous users, although the second CRT terminal is extra. The printer is a 150cps, 9x7 dot matrix, handling both 80 and 132 column commands, plus expanded type printing under software control, bi-directionally.

General ledger, payroll, accounts receivable, word processing and order entry. Software is included. $10,995.

Parke-Randall Corporation, 12218 Morrison St., North Hollywood, CA 91607.

CIRCLE 242 ON READER SERVICE CARD

HOME BUILDER'S BUSINESS SYSTEM

Dalcon International, Inc., has introduced its Home Builders Business System, a turnkey, microcomputer system consisting of a North Star Horizon II computer, video terminal and printer.

The system does complete job costing, allowing each house under construction to be broken down into up to 99 user definable cost centers. It also provides a general ledger which keeps track of accounts payable to vendors and subcontractors as well as providing financial statements.

Dalcon International, 511 Woodbine Ave., Nashville, TN 37211. (615)242-5801

CIRCLE 243 ON READER SERVICE CARD

3D

DIAGRAMS

Have you ever looked at a diagram on flat paper and tried to imagine what it is supposed to represent in real three dimensional space? If you have you will love this program. With "3D Diagrams" you can make diagrams that look real—they stand right up off the page. 3D DIAGRAMS is a program listing—don't worry, it is not too long to type and it is written in standard BASIC and will run on any BASIC computer. (TRS-80, PET, APPLE, etc.) Along with the listing you get everything you need to make any 3D diagram plus a clear explanation and easy to understand instructions. Send your $10.00 (U.S.) check or money order now! Distributed by:

Peter R. Spenler
913 Elgin St. #1
Wallaceburg, Ont.
Canada N8A 3C9

CIRCLE 189 ON READER SERVICE CARD

The "DATA DUBBER"

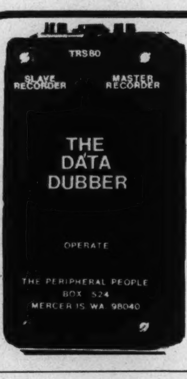
DUPLICATES ANY PROGRAM TAPE

TRS-80

Yes, even those in machine language! Feed your cassette into the "Data Dubber" and get out exact replicas of the TRS-80 CSAVE data pulses. Obtain perfect CLOAD's even from tapes with hum, distortion, or minor dropouts. . . and without constantly adjusting the volume. Connect a second cassette to the "Data Dubber" and make perfect reproductions, just as if the data had come from the TRS-80.

The "Dubber" works with Level I or II and costs only **$49.95** postage paid. Start your own software business. Pays for itself in time saved and reduced tape cost. Order the "Data Dubber" today! If you are not completely satisfied with its performance simply return it for full refund.

P.O. Box 524-CC



THE PERIPHERAL PEOPLE PO Box 524, Mercer Island, WA 98040

CIRCLE 200 ON READER SERVICE CARD

DOES YOUR COMPUTER SOMETIMES COUGH, SNEEZE OR HAVE A SEIZURE?

It may be suffering from Transiet Glitchitis, a cureable digestive disorder. The Blitz Bug can bring fast relief from these symptoms in less than 50 nano seconds. Available without prescription. Use only as directed.

* No Computer Should Be Without One *

Blitz Bug protects your entire circuit, and plugs into any outlet.
$19.95, Two for $35.00
N.J. Residents add 5% sales tax
Add $1.50 shipping&handling delivery from stock

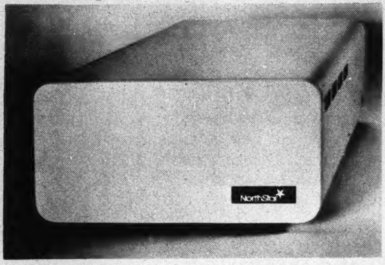
Omni Communications Co., Inc.
Jackson, New Jersey 08527

CIRCLE 174 ON READER SERVICE CARD

DISK SYSTEMS

HARD DISK FOR NORTH STAR

North Star Computers Inc. has announced a Winchester-type 18Mb hard-disk enhancement for its Horizon computers. A unique method is used for backing up the information stored on the disk: the information that is modified each day is backed up on floppy disk, on a sector-by-sector basis.

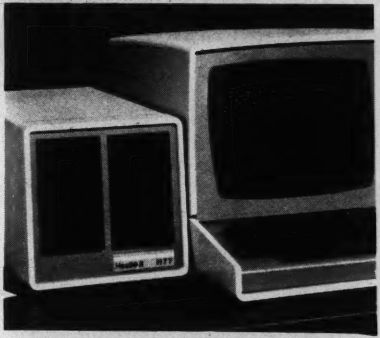


The drive consists of the 18Mb Winchester-technology hard disk, enclosure, power supply, controller, cables and software. Software includes a hard disk operating system (HDOS), North Star Basic and back-up and recovery facilities.

North Star Computers, 1440 Fourth St., Berkeley, CA 94710. (415) 527-6950.

CIRCLE 244 ON READER SERVICE CARD

HEATH FLOPPY DISK ACCESSORY FOR H89



Heath Company has introduced a floppy disk accessory for its Heathkit H89 Computer.

The H-77 Floppy Disk System uses standard 5 1/4", hard sectored 40-track diskettes. Each diskette is capable of storing 100K bytes of data.

The H-77 Floppy Disk System, mail order priced at $595 in kit form, includes one disk drive. The H-17-1 Disk Drive, mail order priced at $325, is available to provide two-drive capability for the H-77.

Heath Company, Dept. 350-280, Benton Harbor, MI 49022.

CIRCLE 245 ON READER SERVICE CARD

TRS-80 DUAL DISK DRIVE

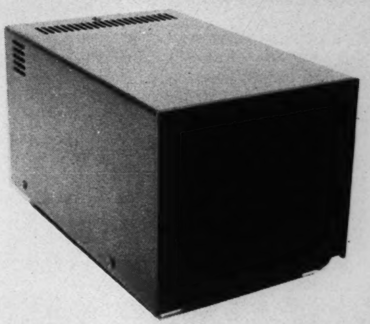
Computhink, Inc. has introduced a TRS-80 compatible dual disk drive with a capacity that is equal to four Radio Shack disk drives.

The single density, dual-head 5¼" minifloppy drives provide 400K bytes of on-line storage capacity by recording on 40 tracks per side.

The plug-compatible dual disk drives utilize the TRS-80 disk controller and are compatible both with the TRS-80 Disk Operating System and standard Radio Shack diskettes. $1295.

Computhink, 965 West Maude Ave., Sunnyvale, CA 94086. (408) 245-4033.

CIRCLE 246 ON READER SERVICE CARD



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530 Claremount Ave.
P.O. Box 571
Ashland, Ohio 44805

CIRCLE 114 ON READER SERVICE CARD

THIS MONTH'S SPECIALS

SPECIAL #1

If you purchase the "TRS-80 DISK AND OTHER MYSTERIES" Book for the regular price of $22.50
you can buy 10 VERBATIM DISKETTES
AND a plastic library case for $22.00
TOTAL $44.50

*** FREE SHIPPING FOR ORDERS OVER $20.00 ***

SPECIAL #2

If you purchase APPARAT NEWDOS+
for the regular price of $99.95
you can buy 10 VERBATIM DISKETTES
AND a plastic library case for 5.00
TOTAL $104.95

*VERBATIM DISKETTES $26.50
or the best price you find minus — 50¢

*PLASTIC LIBRARY CASE $2.50

•FLOPPY SAVER (reg·$14.95) $11.95

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VISA

CIRCLE 104 ON READER SERVICE CARD

TELEPHONE PROGRAM FOR TRS-80

1. Indexed and alphabetized directory.
2. Auto, manual and delay dialer.
3. Display timer.
4. Running display call cost calculator.
5. One key redial.
6. Delay redial.
7. Record call file.
8. Read call file, and more.

Level II 16k....$10.95 postpaid

Other programs of interest to photographers available for TRS-80, TI 59.

CALL OR WRITE FOR DETAILS

D-SOFT
319 Clarendon Ave.
Southport, N.C. 28461
(919) 457-5157

CIRCLE 122 ON READER SERVICE CARD

Meet GARCAN our radio controlled Robot made from a Trash Can. The parts used are "hardware store" items and are available locally. We've built several of these Robots and put together an assembly manual which sells for $50.00. The manual covers the drive system, power supplies, motor control circuits, and the body. We accept Visa, Mastercharge, checks & money orders. Texas residents must add 6% Sales Tax. Call, write or use the reader service card and we'll send our information sheet.

Jerry Rebman Electronics
3530 Timmons Lane #155
Houston, Texas 77027
(713) 621-8429

VISA
master charge

CIRCLE 145 ON READER SERVICE CARD

INFORMATION EXPLOSION?

GET INFORMATION MASTER!

Are you overwhelmed by your collection of reprints, technical literature, spec. sheets, magazine articles, correspondence, etc.? Get back in control with the INFORMATION MASTER program.

Use combinations of keywords to quickly find exactly what you want. Search a 500 entry data base in 12 to 15 seconds and retrieve essentially unlimited text.

INFORMATION MASTER runs on 8080 or Z-80 microcomputers using a CP/M compatible operating system and having at least two disk drives and 32K of memory. Disk formats available: 8" single density, Vector Graphic 5", Heath H-89 5" (modified CP/M).

INFORMATION MASTER program is shipped ready to run, on disk with demonstration data base and 22 page users manual.

-$ 37.50, postage paid-

Island Cybernetics
P.O. Box 208, Port Aransas,
TX 78373
(512) 749-5843

CIRCLE 143 ON READER SERVICE CARD

SYSTEMS SOFTWARE

LANGUAGES

PCD Systems, Inc. announces the release of **USCD Pascal** for the TRS-80 Model II. The standard package includes an interactive operating system with run time support routines, P-code interpreter, compiler, screen editor, character oriented editor, Z-80 macro assembler, linking loader, patch/dump utility program and other utilities. $350. PCD Systems, Inc., P.O. Box 143, Penn Yan, NY 14527. (315) 536-3734.

CIRCLE 247 ON READER SERVICE CARD

Business Microproducts announces the **Nevada Cobol** compiler for the TRS-80 Model I and II, which translates source language programs into machine language programs. The compiler, run time package, sample Cobol program and terminal configuration program are supplied on a CP/M data diskette. $99. Business Microproducts, Livermore Financial Center, 1838 Catalina Ct., Livermore, CA 94550. (415) 443-4876.

CIRCLE 248 ON READER SERVICE CARD

Lisp/80 is a full implementation of Lisp 1.5. Supplied on 8" single density floppy disks for CP/M users, it offers pattern matching and recognition, robot simulation, game playing programming, general problem solving and natural language processing. $75. T.W. Yonkman, 4182 Caminito Islay, San Diego, CA 92122.

CIRCLE 249 ON READER SERVICE CARD

SYSTEMS

Microsoft Consumer Products announces a **Basic Compiler** for the TRS-80 which compiles programs written with the TRS-80 disk Basic interpreter, producing Z-80 machine code that is directly executed by the TRS-80. The package includes two diskettes containing the Basic Compiler, Basic run time library and Link-80 linking loader; instruction manual and reference manual for Microsoft 5.0 Basic. $195. Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004. (206) 454-1315.

CIRCLE 250 ON READER SERVICE CARD

The Optimized Systems Software Group announces a disk-based operating system package for the Apple II. The complete package consists of CP/A (**Control Progam/Apple**), including a set of disk utility commands similar to those of the 8080-based CP/M, and fully compatible Basic, Text Editor, Assembler and 6502 Debug programs. $89.95. Shepardson Microsystems, Inc., 20823 Stevens Creek Blvd., Bldg. C4-H, Cupertino, CA 95014. (408) 257-9900.

CIRCLE 251 ON READER SERVICE CARD

LSPOOL is a line printer spooling facility for the TRS-80 which permits concurrent printing in the foreground while normal TRSDOS operation continues in the background. A two-disk 32K or 48K system is required to support the 3K assembler program. $39.95. Automated Resource Management, Inc., P.O. Box 4353, Irvine, CA 92716. (714) 963-2975.

CIRCLE 252 ON READER SERVICE CARD

Altair CP/M from Lifeboat Associates is implemented on the Altair 8800 and MITS 3202 series of floppy disk sytems and allows users to take advantage of the 300K capacity per disk, and gives them access to the broad range of systems and applications software available. $145. Lifeboat Associates, 2248 Broadway, New York, NY 10024. (212) 580-0082.

CIRCLE 253 ON READER SERVICE CARD

EDAS 4.0 from Galactic Software is a RAM-resident text editor and assembler for the TRS-80 Model II. The editor provides text editing facilities for the modification of alphanumeric text files. The assembler portion facilitates the translation of Z-80 symbolic language source code programs into machine executable code. $229. Galactic Software Ltd., 11520 North Port Washington Rd., Mequon, WI 53092.

CIRCLE 254 ON READER SERVICE CARD

TED is an advanced editor for microcomputers which implements a large subset of commands from TECO, an advanced editor which DEC supplies with its minicomputers. Its features include sophisticated macro structures, iterative and conditional execution of commands, 36 command/text buffers and a 32-entry push-down stack. TED runs on Z-80 systems supporting CP/M. $90. Small System Design, P.O. Box 4546, Manchester, NH 03108. (603) 432-7929.

CIRCLE 255 ON READER SERVICE CARD

The Matchmaker enables users of North Star Basic and CP/M to combine the power of both. It offers North Star owners dynamic file extension and creation, automatic reclamation of deleted files and all other features of the CP/M operating system. $89.95. The SoHo Group, 140 Thompson St., Suite 4-B, New York, NY 10012.

CIRCLE 256 ON READER SERVICE CARD

The Advanced Application Development System for the TRS-80 Model II includes a data base handler, display control monitor, indexed sequential file support, advanced executive language, high speed Basic compiler/interpreter, commercial-level operating system and documentation support. The Software Firm, Inc., P.O. Box 6267, Denver, CO 80206. (303) 778-7473.

CIRCLE 257 ON READER SERVICE CARD

APPLE

SUPER SALE

16K Apple II or Apple II Plus	$995.00
Apple Disk II w/controller	$529.95
Apple Soft or Integer Cards	$159.95
Pascal Language Card	$459.95
10 Megabyte Disk for Apple	$4695.00
DC Hayes Modems	$339.95
Graphics Tablet	$695.00

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THE LOWEST

prices on this high-quality software. Buy direct and save 50%. Now, also available for CBASIC on CP/M and MBASIC on HEATH HDOS.

DATA BASE MANAGER **Mod-I $69 Mod-II $199**
You can use it to maintain a data base & produce reports without any user programming. Define file parameters & report formats on-line. Key random access, fast multi-key sort, field arith., label, audit log. No time-consuming overlays. 500 happy users in a year. Mod-II version with over 50 enhancements.

A/R **Mod-I $69 Mod-II $149**
Invoices, statements, aging, sales analysis, credit checking, form input, order entry. As opposed to most other A/R, ours can be used by doctors, store managers, etc.

WORD PROCESSOR **Mod-I $49 Mod-II $49**
Center, justification, page numbering...Used for letters, manuals, and reports. Mod-I version features upper/lower case without hardware change!

MAILING LIST **Mod-I $59 Mod-II $99**
The best! Compare and be selective. Form input, 5-digit selection code, zip code ext., sort any field, multiple labels. Who else offers a report writer?

INVENTORY **Mod-I $99 Mod-II $149**
Fast, key random access. Reports include order info, performance summary, E.O.Q., and user-specified reports. Many converted their inventory to ours!

PAYROLL, A/R, A/P, and GL available for the Mod-II DOS and CP/M.

L216, a cassette package of 10 business programs for Level II 16K systems. $59.

MICRO ARCHITECT, INC.,
96 Dothan St., Arlington, MA 02174

CIRCLE 155 ON READER SERVICE CARD

Wintek announces a **C compiler** for the 6800 microprocessor which is intended to run under the Wizard multi-tasking disk operating system on the Sprint 68 microcomputer. $4.95. Wintek Corporation, 1801 South St., Lafayette, IN 47904. (317) 742-8428.

CIRCLE 258 ON READER SERVICE CARD

RSMII is a machine language monitor for the TRS-80 Model II. It has all the features developed for the Model I plus a video editor for examining and modifying both memory and disk sectors. $39.95. Small System Software, P.O. Box 366, Newbury Park, CA 91320.

CIRCLE 259 ON READER SERVICE CARD

DATA BASE PACKAGES

Database Two is a data base management system written in Micropolis Basic for the TRS-80 Model II. It allows the user to create, maintain, add, edit, delete, sort, search, inspect and print data files of up to 1200 entries each. $125. Bonjoel Enterprises, P.O. Box 2180, Des Plaines, IL 60018. (312) 297-2921.

CIRCLE 260 ON READER SERVICE CARD

APPLICATIONS SOFTWARE

RECREATIONAL, GAMES

Parsector V is a space war game for the TRS-80 Level II computer in which two players plot their strategies using private video displays hidden from their opponents. The game features a split screen display format and instructions for building a cardboard screen divider hood. $19.95. Synergistic Solar Inc., P.O. Box 560595, Miami, FL 33156.

CIRCLE 261 ON READER SERVICE CARD

The Stone of Sisyphus is the second game in the Maces and Magic series of role-playing adventures for the TRS-80. It allows the player to create, outfit and use characters to explore a subterranean world of monsters, magic, traps and treasures. Chameleon Software, Inc., 4733 N. Mitchner, Indianapolis, IN 46226.

CIRCLE 262 ON READER SERVICE CARD

Electra Sketch for the TRS-80 is an animation and graphics compiler with which the user can create a picture frame using one-key commands to control cursor direction, draw, erase, draw vectors, fill in backgrounds with any sequence of characters, save on disk or recall from disk. Macrotronics, 1125 N. Golden State Blvd., Suite G, Turlock, CA 95380.

CIRCLE 263 ON READER SERVICE CARD

The **Allen Music Box** 1 series for Commodore microcomputers features compositions by Bach, Chopin, Mozart and Sousa. In the **Allen Animation** 1 series music is combined with animated figures on-screen. Both run on 8,16, and 32K PETS. $10. Allen Computer Products, Box 2283, Livonia, MI 48151.

CIRCLE 264 ON READER SERVICE CARD

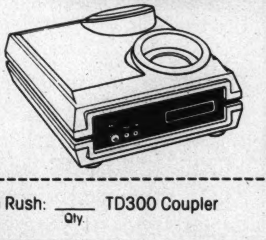
Wumpus Adventure for the Atari 800 combines two of the most popular computer games and adds color graphics and sound effects. $14.95. Sebree's Computing, 456 Granite Ave., Monrovia, CA 91016. (213) 359-8092.

CIRCLE 265 ON READER SERVICE CARD

Dungeons is a fantasy adventure for the OSI in which the player takes the role of a fighter, dwarf, halfling, elf or magic-user in search of gold in the unexplored dungeons beneath the Wizard's city or in the forest surrounding it. $12.95 for cassette or $15.95 for disk. Aurora Software Associates, 353 S. 100 E. #6, Springville, UT 84663. (801) 533-8002.

CIRCLE 266 ON READER SERVICE CARD

Acoustic Coupler Sale



- 1 Yr Warranty (RTN to Factory)
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$145 ea. Texas Residents Add 5% Sales Tax

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Qty.
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Signature ______________________________
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CIRCLE 191 ON READER SERVICE CARD

The subLOGIC FS1 Flight Simulator*

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OIL T-220
FUEL-24
TACH-100

is just one application of our fine graphic software.

Other applications can be yours!

Choose from a coordinated software and hardware collection to fit your graphic needs . . .

SOFTWARE

A23D1 animation package for the Apple II ($45 on cassette, $55 for disk)

8080/Z80 3D package for most S100 systems ($41 on tarbell cassette or paper tape, $51 on 5" North Star disk, or $52 on 8" CPM disk).

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*The FS1 Flight Simulator is available for Apple II and TRS-80 Level I & II for $25 on cassette.

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CIRCLE 187 ON READER SERVICE CARD

Aresco, Inc. announces **Kim-Venture**, an adventure game for use on a standard 1K Kim-1 Microcomputer. The package contains a Kim cassette, a 32-page operator's manual and three pages of player instructions. $24.95. Aresco, Inc., P.O. Box 1142, Columbia, MD 21044. (301) 730-5186.

CIRCLE 267 ON READER SERVICE CARD

Soundware includes the software and hardware necessary to allow the user to make music and sounds on the Compucolor II. $49.95. Compucolor Corporation, 225 Technology Park/Atlanta, Norcross, GA 30092.

CIRCLE 268 ON READER SERVICE CARD

EDUCATIONAL

Super-CAI for the TRS-80 is an expanded version of CAIware with the following additional features: menu option six is implemented in the CAI-Author program, providing the capability to review and modify lesson screens on tape; the CAI-Copy program is provided for backing up CAIware lesson tapes and improving performance by means of data compression. $64.95. **CAI-2D** is a disk version of Super-CAI with the added capability of composing tests from a databank of questions, and maintaining student performance records on disk. $125. Micro-Gnome, 5843 Montgomery Rd., Elkridge, MD 21227. (301) 796-4165.

CIRCLE 269 ON READER SERVICE CARD

A **Management Simulation Game** based on games played at graduate business schools by teams of managers is now available in North Star Basic. Each player or team controls a company manufacturing three products and competing against other companies, each of which sells three similar products. Certified disk, $17.50; hardcopy listing, $12.50. GIGA, P.O. Box 1881, Chicago, IL 60690.

CIRCLE 270 ON READER SERVICE CARD

Educational Activities, Inc. announces programs for math, language arts, spelling and class management. **Introduction to Math on the Computer**, **Introduction to Decimals on the Computer** and **Missing Math Facts** cover several levels of difficulty and are self-scoring. There are 16 **Language Arts** programs dealing with nouns, pronouns, verbs, adjectives, adverbs, homonyms, synonyms, antonyms and contractions. Spelling programs include **Scrambled Letters** and **Flash Spelling**. The class management programs are **Readability Index**, which enables the teacher to determine the reading level of any text, and **Grade Averages**, which calculates students' grade averages by using both numeric and letter grades. Educational Activities, Inc., P.O. Box 392, Freeport, NY 11520. (800) 645-3739.

CIRCLE 271 ON READER SERVICE CARD

Study Quiz Files is a teaching program for the Apple II which enables a teacher to create, save, retrieve, revise or run study quizzes on any subject without any programming knowledge. **Multiple Choice Files** is a similar program for multiple choice tests. Both include randomized questioning and immediate feedback learning strategies. Apple-Cations, 21650 W. Eleven Mile Rd., Southfield, MI 48076.

CIRCLE 272 ON READER SERVICE CARD

The **Elementary Math Edu-Disk** for the 48K Apple II contains an arithmetic readiness test and four interactive lessons designed to teach elementary addition, subtraction, multiplication and division on nine different skill levels. $39.95. Muse Software, 330 N. Charles St., Baltimore, MD 21201. (301)659-7212.

CIRCLE 273 ON READER SERVICE CARD

Language Teacher programs in French, Spanish, German and Italian feature a drill learning format with language-to-English or English-to-language usage options. Each TRS-80 program offers word combinations, phrases and verb conjugation forms. $19.95. Acorn Software Products, Inc., 634 North Carolina Ave., S.E., Washington, D.C. 20003.

CIRCLE 274 ON READER SERVICE CARD

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CIRCLE 165 ON READER SERVICE CARD

Tycom Associates announces the **Educational Software Series** for the Commodore PET/CBM computers. The series is available on cassette tape, and includes Algebra ($19.95), French and Vocabulary ($15.95). Tycom Associates, 68 Velma Ave., Pittsfield, MA 01201.

CIRCLE 275 ON READER SERVICE CARD

BUSINESS

North Star Computers has announced four application software packages. **NorthWord** is a word processor which includes easy entry and editing, on-screen text formatting and simultaneous document printing. $399. **MailManager** is used to compile and maintain complete organized mailing lists. $299. **InfoManager** is a list-oriented information management system which will accept up to 50 categories of information for each record and has the ability to select and sort before printing. $499. **GeneralLedger** includes both general ledger and financial reporting programs. It can combine with NorthWord to use the information in the general ledger to produce customized financial statements and reports. $999. North Star Computers, Inc., 1440 Fourth St., Berkeley, CA 94710. (415) 527-6950.

CIRCLE 276 ON READER SERVICE CARD

The Estimator is a menu-driven program for TRS-80 and CP/M systems which assists the user in preparing and organizing a detailed estimate. Written in Microsoft Basic, it allows entries for the item title, material quantity, unit cost of material, and hours required. Prices start at $30. **The Framing Calculator** is designed to assist general contractors, architects, construction estimators and engineers in calculating estimated labor and material requirements for general wood frame construction. Also written in Microsoft Basic, it is available for $100. Mendocino Software Development, P.O. Box 1564, Willits, CA 95490.

CIRCLE 277 ON READER SERVICE CARD

ACCT-M2 for the TRS-80 consists of five programs that carry out the on-line accounts receivable functions of a small business or medical clinic. Its three basic functions are initialization, data base management and report generation. $149. Micro Architect Inc., 96 Dothan St., Arlington, MA 02174.

CIRCLE 278 ON READER SERVICE CARD

Your CP/M system just isn't worth its salt...until it's been through a night like this.

The Pirate stands ready to challenge your CP/M system to a battle of wit and endurance. As you traverse uncharted lands and seas, you'll meet up with wild animals, magical beings and a smart alec parrot. **Adventureland** and **Pirate Adventure** are two of the most mind-bending game simulations you'll ever encounter. (CS-9003) $24.95.

Original Adventure is an undisputed classic. The treasures you seek are hidden in underground caverns. All you have to do is find them. It's easy...just overcome a giant clam, nasty little dwarves and other deathly perils. This game is bi-lingual so, to make it really a cinch, just type in "GO FRANCE" and the characters will speak and understand only French. (CS-9004) $24.95.

The Basic Games Library features 190 top-notch simulations, battles and strategy games from the celebrated Basic Computer Games Book and its sequel, More Basic Computer Games. **Volume I** (CS-9001) and **Volume II** (CS-9006) include Super Star Trek, Slalom, and Checkers. Each disk is $24.95. Both disks and the Basic Computer Games Book are available for only $50.00 (CS-9000).

Volume III (CS-9005) and **Volume IV** (CS-9006) feature Yahtzee, Tennis, Wumpus and Grand Prix. The disks are $24.95 each. Both disks and the More Basic Computer Games Book are $50.00 (CS-9007). The entire four disk collection also includes both big games books, edited by David Ahl, and is $95.00 (CS-9008). All are on 8" disks, require 48K and Microsoft Basic.

Your local computer store should carry Creative Computing Software. If your favorite retailer does not carry the software you need, have him call in your order to 800-631-8112. Or, you can order directly from Creative Computing. Write to Creative Computing Software, Dept. AHGG, P.O. Box 789-M, Morristown, NJ 07960. Include $1.00 for postage and handling. For faster service, call in your bank order toll free to **800-631-8112**.

sensational software

CIRCLE 300 ON READER SERVICE CARD

National Software Marketing, Inc. announces **Accounts Receivable, Accounts Payable** and **General Ledger** programs for the TRS-80 Model II. It accomodates 200 vendors, 500 customers and a chart of accounts of 250. The system is in Basic and operates under the standard TRSDOS operating system. $150. National Software Marketing, Inc., 4701 McKinley St., Hollywood, FL 33021. (305) 625-6062.

CIRCLE 279 ON READER SERVICE CARD

Data Processing Consultants introduces two packages for the TRS-80 Model I which are designed to allow effective management of a small retail business. A **Balance Forward Accounts Receivable** program keeps track of transactions each month on account, and a Retail Inventory Control program keeps track of inventory and sales information on each of 99 departments. Accounts Receivable sells for $200, and Inventory sells for $400. Data Processing Consultants, 304 S. Dunlap, Paris, TN 38242. (901) 642-0127.

CIRCLE 280 ON READER SERVICE CARD

Computer Services of Encinitas supplies the complete line of Osborne business applications programs in CBasic2 for the North Star MicroDisk System. **General Ledger, Accounts Payable, Accounts Receivable and Payroll** programs are custom configured to match the purchaser's disk and terminal. $125. Also available in North Star Basic are the 97 programs included in the Osborne book **Some Common Basic Programs.** $25. Computer Services of Encinitas, 341 Willowspring Dr., Encinitas, CA 92024. (714) 436-2486.

CIRCLE 281 ON READER SERVICE CARD

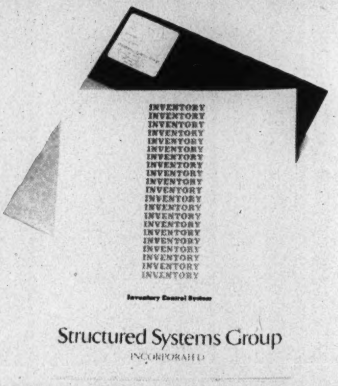
Taranto & Associates announces an **Accounts Receivable/Invoicing System** for the TRS-80 Model II. The system features an open item accounting system, the ability to bill up to 51 items on a single invoice and the ability to calculate service charges. It prints statements as well as invoices. $249.95. Taranto & Associates, Inc., Box 6073, 4136 Redwood Hwy., San Rafael, CA 94903. (415) 472-2670.

CIRCLE 282 ON READER SERVICE CARD

The Electric Abacus introduces **Real Estate Index and Locator,** a system of Basic language programs designed to assist real estate agencies in finding properties for customers. The interactive search and sort programs match home specifications of a prospective buyer with current active MLS listings. I It also provides financial information for the buyer. The program, called Reiley, is available for the North Star disk system with a single drive and 24K or memory. The Electric Abacus, 19 Mayfield Rd., Regina, Saskatchewan, S4V 0B7 Canada.

CIRCLE 283 ON READER SERVICE CARD

A CP/M-based **Inventory Control** software package for small to medium sized businesses is able to support up to 32,767 inventory item records, and provides up-to-date, information on the quantity, value, and activity of inventory items. It includes an "auditability option" to create an ongoing hardcopy record of stock additions and depletions.



The system requires CBasic2 and runs on most CP/M systems with dual floppy disk drives and 48K of user memory. Structured Systems Group, 5204 Claremont Ave., Oakland, CA 94618. (415) 547-1567.

CIRCLE 284 ON READER SERVICE CARD

Inventory One for TRS-80 Model II consists of ten programs which generate nine basic reports, including inventory, orders, vendor listings, reorder status, receiving, stock locations, parts lists, cost lists and price lists. $125. Also available is a **Client Billing System** which creates both client data and billing data files. Both systems are compatible with Database Two. Bonjoel Enterprises, P.O. Box 2180, Des Plaines, IL 60018. (312) 297-2921.

CIRCLE 285 ON READER SERVICE CARD

Datasmith announces **Payroll** and **Bookkeeping** software packages written for users of Micropolis Basic. The menu-driven systems are interactive and provide full features with a variety of printed reports. Both require at least 40K of RAM and two disk drives. Datasmith, 15501 W. 109th St., Lenexa, KS 66219.

CIRCLE 286 ON READER SERVICE CARD

A **Weekly-Payroll** package for the Apple II requires 32K RAM, two disk-drives and a printer. It handles up to 200 employees identified by name, social security number and address; computes gross pay; derives net pay by computing and deducting applicable taxes; and produces weekly, quarterly and annual employee pay reports. $185. NSP, Inc., P.O. Box 3092, Crofton, MD 21114. (301) 956-3476.

CIRCLE 287 ON READER SERVICE CARD

Medical Management System, Dental Management System, Real Estate Multi-List, Insurance Agency, Legal Time Accounting, General Ledger, Accounts Payable, Accounts Receivable, Payroll and **Inventory** from Univair, Inc., are written for the 64K TRS-80 Model II and run in 32K RAM using the latest version of CBasic2. $495 each. Univair, Inc., 10327 Lambert International Airport, St. Louis, MO 63145. (314) 426-1099.

CIRCLE 288 ON READER SERVICE CARD

Med Pac II for the TRS-80 Model II is a medical billing program that handles all patient and third party billing. It will print up to 40 types of insurance forms and provides control of all invoice data for up to 30 doctors. V R Data, 777 Henderson Blvd., Folcroft, PA 19032. (800) 345-8102.

CIRCLE 289 ON READER SERVICE CARD

Graham-Dorian Software Systems introduces a computer software **Dental** Package which handles patient records of charges, payments, insurance, delinquent accounts, and daily and monthly transactions. It prints out patient statements and standard insurance forms for the American Dental Association. The package may be ordered on standard 8" disk or various mini-floppy disks. Graham-Dorian Software Systems, Inc., 211 N. Broadway, Wichita, KS 67202. (312) 265-8633.

CIRCLE 290 ON READER SERVICE CARD

CalData's **DentalWare** for TRS-80 Model II is a self-contained series of programs for the modern dental practice. It's features include: patient personal, financial and insurance record keeping; treatment plans and work history; fully itemized statements; password access to various commands and complete word processing capability. $2600. CalData Systems, P.O. Box 178446, San Diego, CA 92117.

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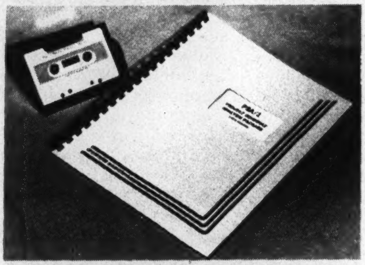

Project Schedule Analysis/1 is a cassette-based introduction to computer-aided scheduling for the TRS-80 Level II and Apple II computers with floating point Basic and at least 16K of memory. It uses critical path scheduling techniques to compute schedules for each job within a project. $25. Express Marketing, P.O. Box 1736/CCM, Poulsbo, WA 98370.

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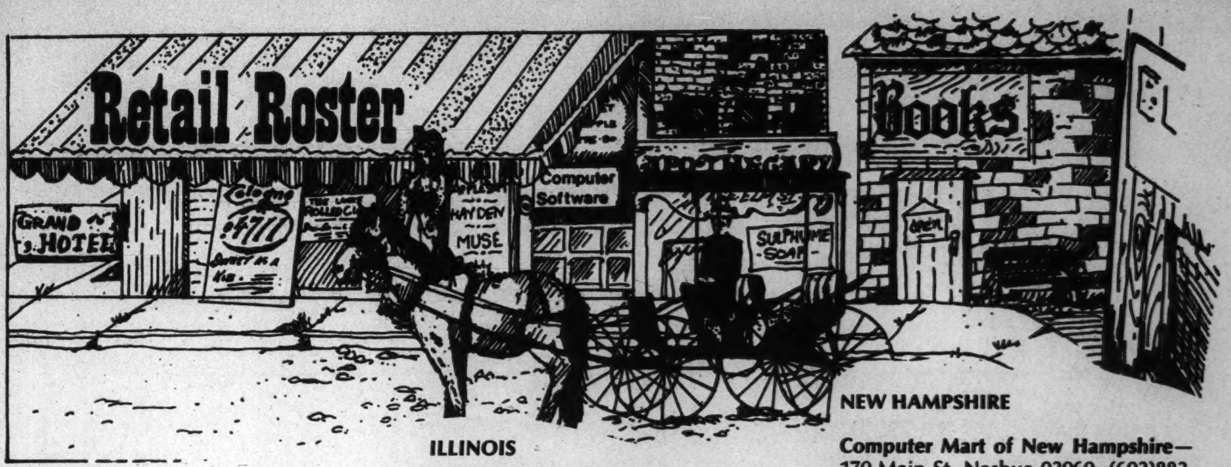

CALIFORNIA

The Computer Store—820 Broadway, Santa Monica 90401; (213)451-0713. 10 am-8 pm Tue-Fri, 10-6 Sat. The Original One! Apple/Vector Graphic.

D.E.S. Data Equipment Supply—8315 Firestone Blvd, Downey 90241; (213) 923-9361. 8AM-9PM 7 days. Complete computer facility—Commodore Pet dealer—"$olid Gold $oftware" specialists.

PC COMPUTERS—10166 San Pablo Ave, El Cerrito 94530; (415) 527-6657. 9-5:30 Mon-Sat. Commodore Pet, Compucolor and Atari.

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The Computer Store—63 S. Main St, Windsor Locks 06096; (203) 627-0188. 10-6 MTWF, 10-8 Thu, 10-4 Sat.

Computerwords— 1439 Post Rd. East, Westport 06880; (203) 255-9096. 12-6 Mon.-Sat., 12-9 Thurs.

FLORIDA

AMF Electronics—11158 N. 30th St, Tampa 33612; (813)971-4072. 10-6 Mon-Sat. Apple Computer Sales & Service; TRS-80, Apple Software & Peripherals; S-100 boards, computer parts & books.

GEORGIA

Atlanta Computer Mart—5091 Buford Hwy, Atlanta 30340; (404)455-0647. 10-6 Mon-Sat.

To include your store in Creative Computing's Retail Roster, call the Advertising Department at (201) 540-9168.

ILLINOIS

ComputerLand/Downers Grove—136 Ogden Ave, Downers Plaza 60515; (312) 964-7762. 10-6 Mon-Sat, 10-8 Tue, Thu.

The Computer Room—106 E. Oak St, Chicago 60611; (312) 337-6744. 11-7 Mon-Fri, 11-6 Sat.

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ComputerLand of Louisville—10414 Shelbyville Rd, Louisville 40223; (502) 245-8288. 10-5:30.

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Computer Mart, Inc.—1395 Main st, Waltham 02154; (617) 899-4540. 11-6 Tue-Sat. Atari, Heath, NEC, SWTP ÷ S-100 bus systems; Word Processing Specialists.

Neeco—679 Highland Ave, Needham 02194; (617) 449-1760. 9-5:30 Mon-Fri. Commodore, Apple, Superbrain, T199/4.

Science Fantasy Bookstore—18 Eliot St, Harvard Sq, Cambridge 02138 (617)547-5917. 11-5 Mon-Sat, 11-8 Thu. Apple Games:Shuttle-Adventure Invader.

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Computer Mart of New Hampshire—170 Main St, Nashua 03060; (603)883-2386. 10-5. Dental-medical computer specialists, Data General & Apple Systems.

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Computernook—Rt. 46, Pine Brook Plaza, Pine Brook 07058; (201)575-9468. 10-6:30 MTWS, 10-8 Thurs., Fri. Apple/Commodore Authorized dealer.

NEW YORK

The Computer Corner Inc—200 Hamilton Ave, White Plains 10601; (914)-WHY DATA. 10-6 Mon-Sat, 10-9 Thu.

OHIO

The Basic Computer Shop—2671 W. Market St, Akron 44313; (216)867-0808. 10-6 Mon-Sat.

Micro Mini Computer World, Inc.—74 Robinwood Ave., Columbus 43213; (614)235-6058, 5138. 11-7 Tue.-Sat. Authorized commodore dealer-Sales/Software/Service/Support.

PENNSYLVANIA

Personal Computer Corp.—24-26 W. Lancaster Ave, Paoli 19301; (215)647-8463. 10-6 Mon-Fri, 10-8 Wed, 10-5 Sat.

VIRGINIA

ComputerLand/Tysons Corner—8411 Old Courthouse Rd, Vienna 22180; (703)893-0424. 10-6 MTWF, 10-9 Thu, 10-5 Sat.

Computers Plus, Inc—6120 Franconia Rd, Alexandria 22301; (703) 971-1996. 10-9 Mon-Fri, 10-6 Sat. Micro specialists, books, classes, software, maintenance. "The PLUS makes the difference."

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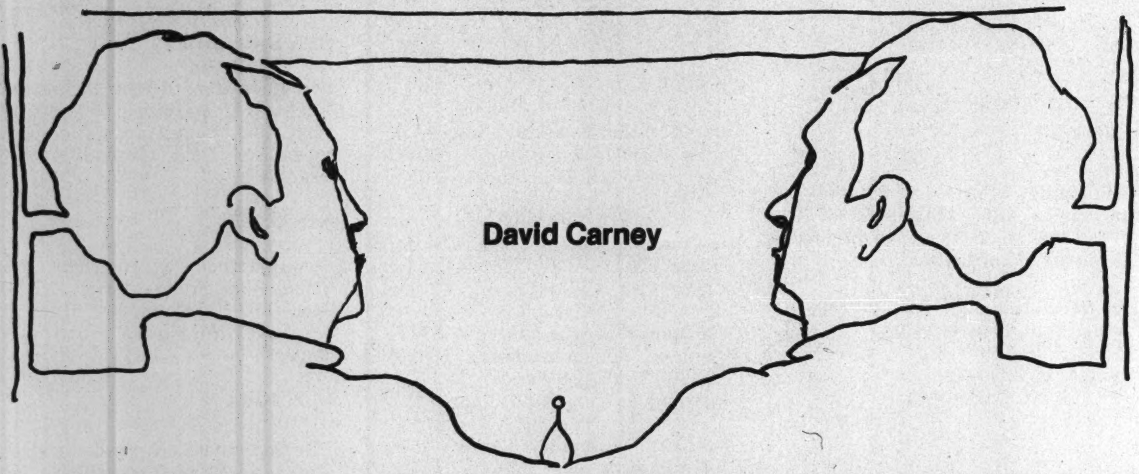


David Carney

The whole house is reeking of formaldehyde because Elaine has got a pair of hamster cadavers in the kitchen, dissecting them, researching some point of biology for her thesis, her research being obscure to me, but that formaldehyde has hit me where I live. I take a shower to clear my head, specifically my sinuses, and after I dry and change, I pause in the kitchen on my way out the door.

"I'm going to walk for an hour or so," I say to Elaine, as she is hunched over the corpses, and the wet, pink guts hanging out of them, her face hidden by her masses of uncombed black hair. She is hunched very close because she is so myopic, and doesn't like lenses for close work. "I'm going to vent my olfactory." (You have to know how to talk to these people, I say to myself.)

"Good, I'll be finished by then," she says from under all the hair. "I'll try to burn some incense or something."

I suck in some clear air once I am outside, and pat my breast pocket, I have not forgotten my wallet, containing my money and contour cards, and I head down the driveway taking long strides, reinforced by the clear, wild starscape.

I am aware of a row of beacons slipping off the 495 exit, which is about five hundred meters down Connecticut Avenue from my house. They are police vehicles, and they whip into my drive, no sirens, beacons throbbing. (Not being an epileptic comes in handy sometimes.) I have practiced law for a couple of years, and have heard horror stories about sloppy, unconstitutional police arrests which I love to tear apart in court afterward. I stand with arms folded as a handful of people spill out of the vehicles, producing electric dart launchers and lasers, and I am more curious than intimidated, even though it is really happening to me, I am being arrested. Why else would they be here, I mean.

"Jacob Silver?" someone asks. There are a total of five officers standing outside a total of three vehicles.

"Yes, I'm Silver. Exactly what do you people want?"

What a trite response, I think. I've really been watching too many detective tapes.

"We have a warrant for your arrest," someone says. All the officers are maintaining their positions by their vehicles, no one is moving forward. In the beacon lights, I can't tell who is speaking. I notice several launchers pointed at me.

"You are suspected of grand theft. Put your hands on top of your head so we don't have to shoot you."

"Fascinating," I say. I put my hands on my head, and an officer steps forward to frisk me and cuff me.

"Don't say anything until your rights are read to you," he admonishes.

And I don't. I get led into one of the vehicles, and we hum away. Christ, what a mess, I think, Elaine will probably never allow me to go for a walk again. Maybe it is a formaldehyde hallucination.

Opposite me at the desk in the five by five foot interrogation room is a bald, paunchy detective sucking on an egregious green cigar, a tag on his lapel which says "Vaccara," and he is telling me that he is only asking preliminary questions.

"I haven't looked at the reports of the detectives who are covering the Arlington National robbery. They work the day shift. Maybe I should."

"Is that the specific charge? Robbing the Arlington National?" I say. "Hey didn't there used to be a cemetery—"

"You are charged with grand theft," Vaccara begins, "and specifically, a teller at Arlington who apparently

---

David Carney, 1105 a, Princeton Ave., Birmingham, AL 35211

has a gift for remembering numbers, happened to remember yours from your contour read-out when you were trying to cash a check this morning, and then proceeded to rob the place."

"Impossible," I assert, incredulous. "I don't have an account there, why would I even go there? Besides, remembering a social security number is no basis for a case—"

"I know," Vacarra smiles deviously, "but you have an Oregon issued social security number. I checked the census records in our computer. Only thirteen people in D.C. have Oregon social security numbers, and only one has one that comes close to yours, and it belongs to a woman."

"Nothing like sticking to fundamentals," I suggest.

"Oh yeah," Vaccara sighs, and stands, grabbing the doorknob behind him, "I love my work. Now I guess I better pull the file on the robbery, and I'll be back in a couple of minutes. I think your lawyer is here. He's going to tell you what a dummy you were to talk to us before he got here."

"I don't have a lawyer," I frown. "I am a lawyer."

Vaccara rolls his eyes and shrugs. "Then I don't know who this is, you have a mystery guest," he says, and leaves.

Paul Casey brushes by Vaccara and into the interrogation room, dropping wearily into the chair where Vaccara had been, looking at me with cow eyes. Casey works for the D.C. public defender, and we and Elaine play euchre together sometimes, which he has made into a contact sport.

"Elaine called me, Jacob," he recounts solemnly. "She heard you talking in the driveway and watched them take you away. You dope."

"Can it, Paul," I say. "Somebody impersonating me robbed the Arlington Bank."

"Yeah, right."

"I'm not kidding, they must have. I didn't do it."

"Allright,now let's consider this," Paul says, gesturing editorially. He rubs his eyes. "What does a person have to do to rob the Arlington Bank? First, one has to get a teller to open her cash drawer—"

"And it won't open until a customer's contour card is matched by the computer. If your facial contours recorded on your card don't match what is being read into the computer by the scanner the teller has on your face, his or her cash drawer won't unlock."

"A pretty substantial circumstantial case," Paul summarizes blearily. "But I don't see that you're very convictable yet."

"Gee, thanks."

"Now what they have to do, they have to prove that it was your contour card that was in the computer, that it was you who was there. Now the computer doesn't keep records of matches. It just does them, that's enough."

"Yes, but I've been told," I interject, "that there is a teller at the bank who has an unusual facility for remembering numbers, and apparently when I — I mean the thief — was robbing her, he had to leave the card in the computer to keep the cash drawer open, and so the teller just memorized the social security number that was on the read-out monitor with his facial contour. And only one other person in this city has an a social security similar to mine, a woman."

"Nonetheless it is merely circumstantial, and you are defendable. May I have the honor?"

"Go counselor, go."

"If there was a record of your contour being fed into the computer at the time of the robbery, which there isn't, they could just get a contour expert to compare the original contour that the computer has on record with a fresh one that they could make in court, all very dramatic but it won't happen. The matching social security number is all they've got, and even that isn't documented, even if the contour had your name recorded on it, it would be no good to them."

"Maybe it's past your bedtime," I say, "but you've forgotten to ask me something very crucial."

"What?"

"Don't you want to know if I did it?"

"Need I ask at all?" Paul smiles, sarcastic.

I squint at him. "I could take that two ways, you creep."

* * * * *

I start to get very popular. Vaccara reappears in the doorway, and he is yelling back out the door to someone, and has a manila file folder in his hand.

"Bug off, willya?" he is insisting. "You can see him after we finish processing things. I'm trying to be patient. I could have you escorted out of here."

"I'll be out here," Elaine's voice growls. "You facist. I'm going to call the Post and the Star. And the networks. You'll have a mob of reporters to contend with in a matter of—"

Vaccara closes the door behind him. "You sure have funny friends," he scowls at me, disapproving. "She sure smells funny."

Vaccara points with his thumb in the air, signaling Paul to concede him the only chair in the room besides mine.

"Oh Christ," Paul says, and squirms to rise and find a place to stand next to the desk, the room becoming crowded.

"Okay buddy," Vaccara groans and sits, opening his manila folder. "We know now that you didn't do it."

"Oh my God —" I begin.

"Is he released?" Paul snaps. "You can't hold him anymore."

"Don't wet your pants, barrister," Vaccara intones, patiently, even though it is a very sarcastic, incitive question. "What is happening here is bigger than you and me." He turns to me. "You can go, but I'd still like to talk to you. Can I buy you a late dinner?"

As it turns out, Vaccara is buying me and Elaine and Paul Casey dinner. We keep it simple, everyone orders chops and rice.

Vaccara is the only one not digging in, he has the manila file folder poised in front of his face, and he is simultaneously reading it and carrying on a conversation with all of us.

"If you wanted to cover this crime up, officially cover it up," he is saying. "How would you do it?"

There is a general pausing of chewing around the table, and all of us stare at the manila folder with Vaccara behind it.

He closes the folder and places it in front of his plate. "I have been instructed," he explains. "To put a lid on the whole thing. It seems that the police have in custody in Chevy Chase, a man with a computer contour identity card which not only has Mr. Silver's contour on it, but it further has instructions on it which cause the federal identity computers to read out 'match' with whoever's face contour is being read into them. I find it interesting."

"I would say it's fascinating," Elaine says, and resumes chewing.

"Fascinating implies that there is something unexpected in a phenomenon."

"Then you are not surprised something like this has happened," I concluded, playing with my rice.

"Why aren't you surprised?" Paul Casey says.

"In my opinion," says Vaccara, "You can record

Identified, cont'd...

identity, but you can't record you. So there will always be impersonators. This contour experiment has been going on in D.C. for six weeks. It was only a matter of time."

"It was supposed to be the ultimate i.d. form," Paul muses. "I guess I never really thought about it."

"The idea of personal records in a central computer has been traditionally considered flagrant, disdained."

"True," Elaine agrees, "but these are people's faces we're talking about. We don't have people being assigned numbers or something. They are being asked to use their own faces to identify themselves. Computers are supposedly verifying what we already know about ourselves. Listen, Congress was considering it for eighteen months, on and off, before the bill showed up to finance the experiment. It didn't seem like such a bad idea. You know what it's like to try to cash a check or something in a strange place. If it could have worked nationwide—"

Vaccara waves his hand to interrupt, furrowing his brow, shaking his head. "Let's stop being theoretical here," he says, "We have proof here that the system can be efficiently bypassed. It will happen again, and the Census Bureau knows this.

"What they need, is a way to cover this Arlington National robbery up, and they have, essentially, instructed my superiors and me to sit on things until they contrive a practical cover up."

Elaine bristles and is about to unload on Vaccara, but Paul, who is next to her, squeezes her arm and frowns at Vaccara.

"Wait a minute," he says, squinting. "Why are you telling us about the cover up idea. That's the *last* thing you should do."

"I need you to keep quiet for twenty four hours," Vaccara says, leaning forward, producing another one of those lousy, green cigars from his breast pocket. There is a no smoking sign, and I think I will yank it from his mouth and stomp on it if he lights it. "I am telling you this because there isn't going to be any coverup. I need to tell a few, receptive, responsive people about it so I am assured, in case anything happens to me."

* * * * *

Elaine always smells funny. Her breath isn't too bad, since she brushes her teeth, but she doesn't use deodorant. Anywhere. We lie in bed, it is three a.m., and she smokes some exotic dope, which is foul.

"I don't care what Vaccara says," she rasps, the smoke taking her voice away. "I think this computer problem is fascinating."

I pull absently at her hair, exploring the mad tangles. "You don't worry too much about your appearance, do you?"

She squints, giving me a corner of the eye glance. "Now think about that," she croaks, trying to hold the smoke in. "There is a conscious decision involved in not combing my hair, right? It isn't as though I forget. In deciding that I don't feel like combing my hair, I am manifesting a concern about my appearance. Right?"

Elaine gets sophistic as hell when she smokes; usually she is just bookish. I try never to argue with her, as I might miss something worth learning.

"You sound like you are leading up to a more ultimate point."

"I attend to my body more spartanly than you do, but I am reasonably clean and healthy."

She drops the joint in an ashtray on the floor near the bed. The phone rings, and when Elaine answers it, it is Vaccara, so she turns the room intercom on.

"How are you,dear?" she says. "You sound as though you have just been party to a coup."

"Oh well, nothing is going to happen to me. The Census Bureau is backing off. There'll be no cover up."

"I always thought you were paranoid," Elaine comments.

"It's been an hour since we talked to you at dinner," I recount.

"I woke people up. I called the Census director at home, and simply said I was going to tell everything, that in fact I already had. Then I called my captain and got her all disoriented and mad. Then I decided to clean my cat's litter box, since I was up and she wasn't—"

"What's going to be the official story in the morning?" I say.

"The truth. Originally they had planned to say that the scanners they use to match contours with the computer were possibly toxically radiant, and shut everything down, hoping that they could improve the computer program so that a match could not be faked. I'm not into information science, but I have a hunch that that kind of insurance is not possible."

"Sounds very cloak and dagger," Elaine observes. "But could you hang up now? Jacob and I were just getting off on some foreplay."

"Oh my God—"

"Catch you later," Vaccara says.

"Yes,bring your cat over some night, and we'll have dinner together," Elaine says. They hang up.

Elaine slides down under the covers and folds her arms, holding herself.

"You think I'm so earthy and all," she suggests.

I consider it. "Yes," I decide. "Crude, even."

"The scanner terminals will be removed from everywhere by the end of the week," she says, envisioning it. "From banks and stores, from the morgue where they have to heat the bodies to get enough radiation for the scanner to get a good image, from the Welfare and unemployment agencies.

"And I love what Paul Casey said at dinner. He said, 'I never really thought about it.' Face contours are just one more scheme to keep track of people, and there are so many people to keep track of, and so many reasons that they have to be kept track of. You have to be born and fed and parented and orphaned and hired and subsidized and consulted and doctored and you have to cash checks and deposit money and buy a car and house, a stereo and television, you have to vote and run for office and get licenses to drive a car or taxi or a bus, or to fly a plane or a jet or a shuttle or get permission to leave the country or enter the country or practice law or hook or sell booze or dope or food. And you have to be identified when you're dead.

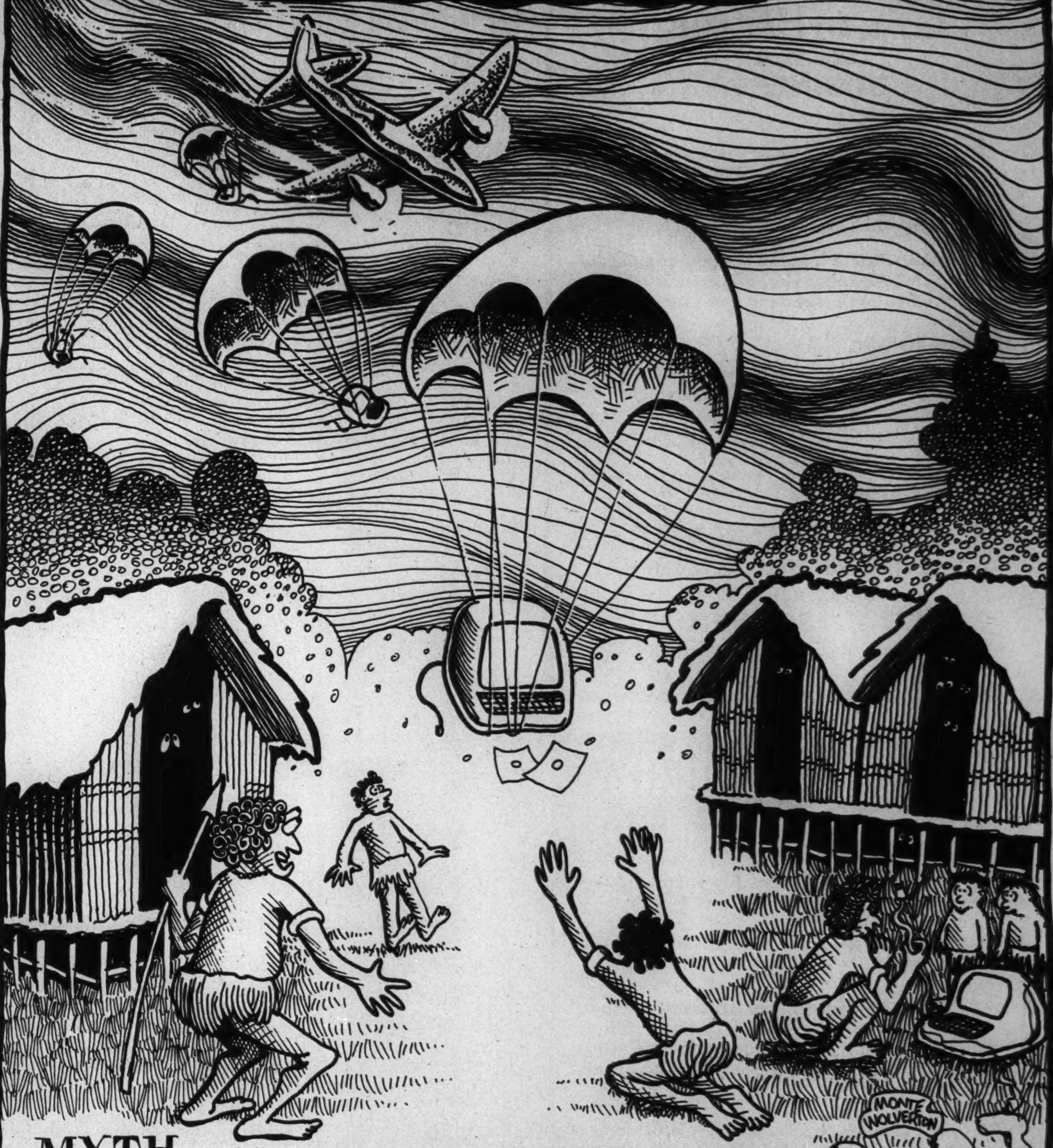
"Nobody really thinks about identification, but it can become more than an expedience. You can become too identified. Somebody borrowed your i.d. and forged another from it. You showed us how to become too identified.

"But I am a child of the sixties and seventies. Appearances, my hippie parents told me, are unimportant, it's identity that counts. It's who you are, not what you are. I don't agree. Appearance is significant. And don't tell me I never think about mine. Identity, that is the problem. I don't get off on identity, but I get off on appearance."

I role my eyes, an embarassed child. "I never really thought about it," I smile. "Foreplay. What was that about foreplay?"

"Ah yes, foreplay," she growls, scooting close to me, so that her face is pressing against my neck. "But are you sure you don't want me to take a shower first?" ■

COMPUTER MYTHS EXPLAINED



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Reviews

Stephen B. Gray

Digital Interfacing With An Analog World, by Joseph J. Carr. Tab Books, Blue Ridge Summit, PA 17214. 406 pages, paperback $8.95. 1978.

This book tells you how to "really put your microcomputer to work," according to the back cover, "how to convert energy produced by pressure, force, position, temperature, etc., into an electrical voltage or current that your microcomputer can deal with. It's for the user who views software as either a simple set of instructions to make the machines go or, more importantly, as a valid substitute for hardware."

The 19 chapters cover transducers, operational amplifiers, signal-processing circuits, some digital circuits, analog function modules, digital codes, data conversion, D/A and A/D converters, analog and digital multiplexing, data-acquisition systems, readout and display devices, serial data transmission, tape recorders and data loggers, and telephone-dialer circuits.

Although most of the math this handbook is full of is on the level of elementary electronics, for a full understanding of what's going on here, the reader should know or learn something about the advanced-math world of delta and sigma.

The book is full of practical circuits, and the two chapters on converters are devoted to "some real products."

Although the writing is a little stiff, there's a wealth of material here, at an easily understood level, for anybody with a head for math and a need to know how to interface the analog world to a microprocessor, computer, or other digital device.

* * *

Basic Computer Programs for the Home, by Charles D. Sternberg. Hayden Book Co., Rochelle Park, NJ. 335 pages, paperback $8.95. 1980.

Here's a collection of 71 programs, all with easily read LISTs and RUNs, in ten categories: Home Financial (checkbook balance, income-tax recording), Automobile Related (auto maintenance, trip planning), Kitchen Helpmates (recipe conversion, supermarket list), Scheduling for Home Use (TV scheduling, reminder calendar), List Programs for Every Purpose (Christmas cards, music collections), Miscellaneous for the Home (school grade recording, weight control), Tutorial for Home Use (math practice, temperature conversion tutor), Conversion (metric, currency), Recreational (wordgame, jogger record) and Hobbyist's Diaries (golf, bowling).

Actually, the book contains 81 programs. Six are given in both basic and extended versions, and three are given in two or three versions (with and without frills).

Although obviously the work that many of these programs do could just as easily (and in many cases, much more easily) be done with three-by-five file cards than a computer, many others should be useful, even if only now and then.

Each program is accompanied by a brief description, instructions for use, data entry, data format, output description, and a LIST and RUN.

This is one of the very tidiest books of its type, a model of how such books should be laid out.

The programs should run on most small computers, except for those that don't have the MIS$ function, used in the wordgame program.

* * *

Home Computers Can Make You Rich, by Joe Weisbecker. Hayden Book Company, Rochelle Park, NJ. 127 pages, paperback $5.95. 1980.

The author's four basic ways to make money with a computer are spelled out in Chapter 2: selling products related to small computers (programs, computer jewelry, information booklets); selling services related to small computers (kit building, custom programming, computer repair); creating new products (writing books, inventing new computer-related games or gadgets); and gambling (invest in small businesses, trade the stock of larger companies, become an option trader or pork-belly speculator).

The book goes into detail on all of these, in chapters on The Microcomputer Industry, What You Need to Know About Making Money, Resources You Can Use, Choosing Your Hardware, Writing For Money, Creating and Selling Programs, Services For Sale, Use Your Imagination, Invest Your Way to Success, Making Your Money Grow, Working at Home.

Two basic principles are detailed in the What You Need To Know chapter: find a need and fill it at a reasonable cost, and never overestimate the intelligence of your customers.

Weisbecker includes much good common-sense material here, no pie-in-the-sky stuff, just telling you how others have made money in a variety of ways. Where applicable, lists are given: books for computer beginners, computer magazines, books about inventing, books about investing.

The back cover says the book is "written by a computer expert and inventor who currently holds 24 patents." What it does not say is that Weisbecker is on the technical staff at RCA's Princeton Research Center, and designed the COSMAC VIP single-board computer.

* * *

Computer Dictionary, by Donald D. Spencer. Camelot Publishing Co., Box 1357, Ormond Beach, FL 32074. 192 pages, hardcover $9.95, paperback $5.95. Second edition, 1979.

This is one of the most recent books by probably the most prolific writer in the field of computers, with three dozen books to his credit. This dictionary is a revised version of the 1977 first edition.

According to the preface, the dictionary has a variety of special features, including computer organizations such as ACM and BEMA, biographies (Mauchly, Hollerith, etc.), programming languages, and historical (EDSAC, ENIAC, etc.). But don't look for extended details on any of these. Under Mauchly, you find "Co-inventor of the ENIAC, an early electronic computer." And under ENIAC, "An acronym for Electronic Numerical Integrator And Calculator. An early all-electronic digital computer. It was built by J. Mauchly and J. Eckert at the Moore School of Electrical Engineering, University of Pennsylvania in 1946."

That gives you an idea of the coverage of what is intended as "a basic reference book for all students of computer science/data processing in schools and colleges." It's quite good as a low-level dictionary, meant for non-technical readers, with easily understood definitions, such as "An ill-assorted collection of poorly matching parts, loosely fit together to form a

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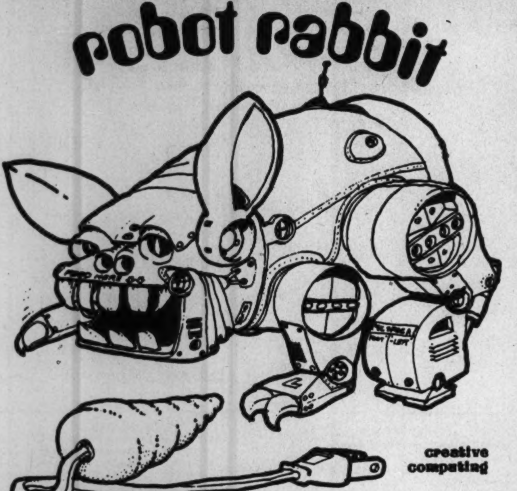

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distressing whole" for kludge. And for floppy disk,"A flexible disk (diskette) of oxide-coated mylar that is stored in paper or plastic envelopes. The entire envelope is inserted in the disk unit. Floppy disks are a low-cost storage that is used widely with minicomputers and microcomputers. See magnetic disk."

* * *

Computer Dictionary. Edfac Publishing Co., 3507 Hunters Circle, San Antonio, TX 78230. 161 pages, paperback $5.95. 1979.

The title inside the cover is "Cartoon-Style Computer Dictionary, 1979." The author is also the publisher, Don Bennet.

This hopeless book is one of those seemingly clever ideas that sound interesting in concept, but which should have been left at that. Each page illustrates with a cartoon what a non-computer person might think a data-processing word or phrase could mean, followed by the real meaning of the word or phrase, as mangled by Bennet, who knows little or nothing about computers.

A couple of examples will suffice to show that this useless dictionary is just too cute for words:

"CRT will probably not become more popular because of the high cost of coffee." The "cartoon" shows a man making a cup of "CR tea," and below is the "real" definition, "A CRT is a Carbon Ray Tube, which is a device that looks like a TV screen with a typewriter attached to it. It is used when someone wants to see some DATA, such as in making airline reservations." That's what it says, Carbon Ray Tube. With a typewriter attached . . .

"A COMMADOR PET is not only the captain's pet, but . . . " is followed by a cartoon of a ship's captain fondling a cat, followed by "it is a MICROCOMPUTER." Commador? Commodore!

This dictionary is my candidate for the title of "Worst Book Ever Written About Computers."

* * *

Computer Programming for the Complete Idiot, by Donald McCunn. Design Enterprises of SF, Box 27677, San Francisco, CA 94127. 128 pages, paperback $5.95.

This is actually a slow-and-easy manual on how to use the Radio Shack TRS-80 computer, and is meant to be used in the hands-on mode. Apparently the author believes you can just walk into a Radio Shack store and use a TRS-80 along with this book. In the introduction, McCunn says the TRS-80 was selected "because Radio Shack has many stores around the United States as well as outlets throughout the world so the TRS-80 is readily available." Then, later, "The convenience of the Radio Shack Stores makes it possible for the reader to try running a computer. The first two sections of the book . . may be processed through a computer in about fifteen minutes."

The first two sections are on The Computer (operating and programming procedures, program storage) and The Computer Program.

The third section, Creating Original Programs, uses a very simple payroll program to illustrate format. The introduction says "The program should be tried out on a computer as much as the reader's circumstances allow." And as much as the store manager allows.

The book can be recommended as a reasonably good beginner's manual for the TRS-80, mainly for those who already have a TRS-80, and for those with enough nerve to use a TRS-80 for an hour or more at a Radio Shack store.

The book is full of "type-in-and-enter" examples for hands-on use, and is written very clearly. The title is perhaps unfortunate, because anyone who buys it is tacitly admitting he's a complete idiot.

◆ ◆ ◆

How to Computerize Your Small Business, by Jules A. Cohen, with Catherine Scott McKinney. Prentice-Hall Inc., Englewood Cliffs, NJ. 182 pages, hardcover $13.95, paperback $7.95. 1980.

Subtitled "Guide to selection and profitable use of computers in your firm," this guidebook was written by the head of a computer-service company that "specializes in working with clients in small businesses who are new to automation," with the help of a college teacher of business and technical writing.

The book starts with an overview of DP, looks at what a computer is (input, output, storage, CPU, programming), options available (service bureaus, time-sharing, in-house computer), selection steps, systems documentation, criteria for selection (operating requirements, response and/or turnaround time, price), the request for proposal, evaluation process, and a case study that takes up almost half the book, 83 pages.

The eight chapters get into as much detail as is possible in such a limited space, and do quite well. There is no room to get into details such as examples of time-sharing costs or more than just a page on software.

The best part of the book is the case study, which does get into great detail, with a dozen flowcharts, skeleton examples of 30 reports, ten screen menus, 19 data-file descriptions, a request for proposal, and a financial evaluation and initial budget.

This is one of the best books available for the small-businessman who knows little or nothing about computers, and who wants all the basics without getting into heavy detail.

◆ ◆ ◆

BCPL - the language and its compiler, by Martin Richards and Colin Whitby-Strevens. Cambridge University Press, New York. 181 pages, hardcover $21.95. 1980.

According to the introduction, "The language BCPL (Basic CPL) was originally developed as a compiler-writing tool and, as its name suggests, is closely related to CPL (Combined Programming Language) which was jointly developed at Cambridge and London Universities . . . The most significant simplification is that BCPL has only one data type — the bit-pattern — and this feature alone gives it a characteristic flavor which is quite different from that of CPL and most other current programming languages. BCPL has proved itself to be useful as a compiler-writing and systems-programming tool. It has been implemented on a wide range of computers, both large and small, and has been used for research and teaching computer science as well as systems programming."

The eight chapters are on the BCPL philosophy; the main features of BCPL; advanced facilities; the library, language extensions, and machine independence; debugging and error-handling; the BCPL lexical and syntax analyzer; compiler portability; and language definition.

BCPL doesn't seem to be implemented on any computer in this country (the only hardware reference in the book is to the XDS Sigma 7), so this book is of interest mainly to hardcore software specialists. ☐

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Crybaby Computer Protects Newborn

When you hear a baby's cry, take note: It may be telling you something more important than "I'm hungry."

That's the idea behind a computer model developed by a Massachusetts Institute of Technology researcher who electronically analyses the crying of newborn babies to detect hidden medical disorders.

The marriage of computer science and medicine will enable doctors to diagnose problems that often remain hidden until later in the baby's life — sometimes until it is too late.

Howard Golub, a Ph.D. candidate in biomedical engineering, has developed a computer program for comparing the components of a baby's cry to the cries of known normal babies.

Eventually it might be used to detect inborn metabolic errors, genetic abnormalities, low blood sugar and brain damage, Mr. Golub said.

Why can a cry tell them so much? Crying is not a simple thing, Golub explained.

"It's the result of complex muscular reactions. The acoustic signal is complex enough that a large amount of information is hidden in there."

A cry can change in frequency, intensity, resonance, timing and a number of other ways.

The investigators compared tape recordings of 55 normal, three-day-old babies to infants with known abnormalities.

They were able to identify 19 out of 21 babies suffering from jaundice and nine out of 10 with respiratory problems.

They also found a cry-analysis of babies who died of sudden infant death syndrome was markedly different from the cries of normal babies.

"The two babies that we look at that later died of SIDS seemed to have constricted vocal chords," Golub said. "None of the other babies that we looked at had those attributes."

The technique is being developed so it can be used routinely in hospital nurseries.

* * *

Casino Computers

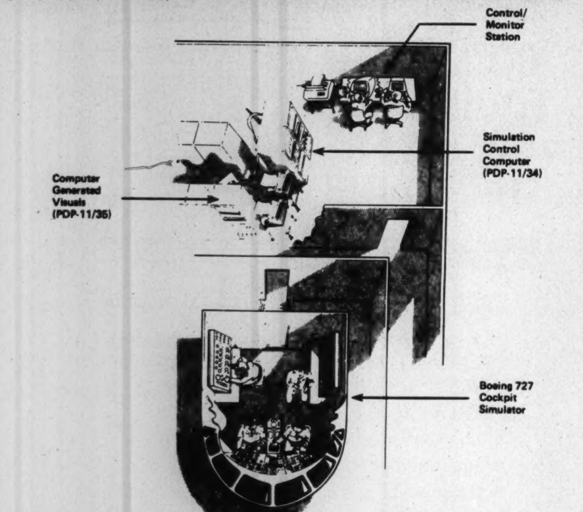
Television-like IBM computer terminals, located throughout the two Harrah's casinos in Reno and Lake Tahoe, help more than 350,000 Harrah's customers who have credit and check-cashing privileges avoid long waits for checks to clear.

The terminals are connected to twin computers that maintain the current status of each customer, after he and Harrah's agree on a credit or check-cashing limit per week. There is one terminal in each "pit," or set of blackjack, baccarat and roulette tables on the casino floor.

As a customer moves from one set of games to another, or even from one Harrah's casino to the other, pit supervisors can enter his name into a terminal, along with a physical description if several patrons have the same name, and receive up-to-the-minute reports on his credit or check-cashing status.

Harrah's also uses the IBM computers to enter reservations for shows at the Reno and Lake Tahoe theaters, up to one month in advance. The two clubs average 21,000 reservation requests each week, with a peak of 52,000 calls in one week for a Frank Sinatra-John Denver show. It was sold out in minutes.

* * *


Control/ Monitor Station
Simulation Control Computer (PDP-11/34)
Computer Generated Visuals (PDP-11/35)
Boeing 727 Cockpit Simulator

Aircraft Collision Avoidance Studies Use New Minicomputer System Simulations

Minicomputer Systems are being used in a series of tests to help develop collision-avoidance system equipment for jet airliners. A PDP-11/34 computer system developed by ARINC Research, linked to the PDP-11/35 computer system controlling a simulated Boeing 727 cockpit, provided warnings of "conflicts" and night-time visual displays of as many as six aircraft in conflict situations to flight crews. Professional airline crews representing several airlines were used in a variety of tests that simulated flights between actual airports. "Conflicts" occurred in airport traffic patterns or en route.

* * *

Computer Circuits, Fastest Yet Made, Reported by IBM

The development of a new family of computer circuits, the fastest yet fabricated, was reported by International Business Machines Corp. researchers.

The circuits, a major advance in an experimental technology, indicate that new computers vastly more powerful than today's models may be available someday. But the circuits are yet to be proved commercially feasible and their practical application, if it ever arrives, is at least a decade off.

Called "current injection logic," the new circuits are of a type known as Josephson junctions, which operate at temperatures so cold that metals lose resistance to electric current. The less the resistance, the faster the current flows — and the faster the computer works.

The new circuits, invented by Tushar Gheewala, a scientist at IBM's Thomas W. Watson Research Center in Yorktown Heights, N.Y., operate in as little as 13 picoseconds, or trillionths of a second. Roughly, a picosecond is to a second what a second is to 30 years.

While today's computer circuits operate in billionths of seconds, far faster computers are needed in some applications, such as weather prediction, that require enormous numbers of calculations.

Faster computers may also bring down the costs of computing, thus making it attractive in more applications and permitting the use of new types of computer programs.

IBM said the 13-picosecond time of the circuits consists of seven picoseconds for switching a circuit and six for the electrical signal to move from one circuit to the next. The speed of the signal is about the same pace that light travels through the same materials — which in theory is as fast as a signal could go.

Books For Classroom And Self Teaching

ALL GRADE LEVELS

Computers in Mathematics: A Sourcebook of Ideas

Here is a huge sourcebook of ideas for using computers in mathematics instruction. This large format book contains sections on computer literacy, problem solving techniques, art and graphing, simulations, computer assisted instruction, probability, functions, magic squares and programming styles.

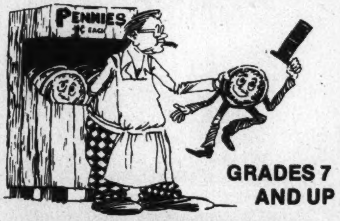
One section presents over 250 problems, puzzles and programming ideas--more than is found in most "collection of problems" books.

Pragmatic, ready-to-use, classroom tested ideas are presented for everything from the most basic introduction to binary numbers to advanced techniques like multiple regression analysis and differential equations. Every item discussed has a complete explanation including flowcharts, programs and sample runs.

The book includes many activities that don't require a computer. And if you're considering expanding your computer facilities you'll find the section on how to select a computer complete with a microcomputer comparison chart invaluable.

Much of the material has appeared in **Creative Computing** but the back issues are no longer available. Hence this is your only source to this practical and valuable material. Edited by David H. Ahl,this mammoth 224-page softbound book costs only $15.95. (The individual issues, if they were available, would cost over $60.00). [12D]

* * *



GRADES 7 AND UP

Computer Coin Games

Computer Coin Games by Joe Weisbecker aids newcomers to the field of computers by simplifying the concepts of computer circuitry through games which can be played with a few pennies and full sized playing boards in the book. Enhanced by outrageous cartoons, teachers, students and self-learners of all ages will enjoy this 96 page softbound book. [10R] $3.95.

STEPHEN J. ROGOWSKI
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COMPUTER
SOLUTION
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Creative Computing Press

Problems for Computer Solution

Stephen J. Rogowski

GRADE 9 AND UP

Here are 90 problems with a thorough discussion and references for each. Eleven types of problems are included, for example, arithmetic, algebra, geometry, number theory, probability and science. Even includes three classic unsolved problems and seven appendices. 104 pages softbound, $4.95 [9Z].

The teacher's edition contains solutions with complete listing in Basic, sample run and in-depth analysis explaining the algorithms and theory involved. 280 pp softbound, $9.95 [9Y].

* * *

The Impact of Computers on Society and Ethics: A Bibliography

REFERENCE

Gary M. Abshire.

Where is the computer leading us? Is it a menace or a messiah? What are its benefits? What are the risks? What is needed to manage the computer for society's greatest good? Will we become masters or slaves of the evolving computer technology? This bibliography was created to help answer questions like these. It contains 1920 alphabetical entries of books, magazine articles, news items, scholarly papers and other works dealing with the impact of computers on society and ethics. Covers 1948 through 1979. 128 pp hardbound. $17.95. [12E].

* * *

GRADES 3 TO 8

Computer Rage

This fun and educational new board game is based on a large-scale multiprocessing computer system. The object is to move your three programs from input to output. Moves are determined by the roll of three binary dice representing bits in a computer. Hazards include priority interrupts, program bugs, decision symbols, power failures and restricted input and output channels. Notes are included for adapting game for school instruction. A perfect introductory tool to binary math and the seemingly-complex computer. [6Z] **$8.95.**

GRADES 4 TO 8

BE A COMPUTER LITERATE
Marion J. Ball & Sylvia Charp

Be A Computer Literate

Marion J. Ball & Sylvia Charp

This informative, full color book is an ideal first introduction to the world of computers. Covers kinds of computers, how they work, their applications in society, flowcharts and writing a simple program. Full color drawings, diagrams and photos on every page coupled with large type make this book easy to read and understand. Used as a text in many schools. 66 pp softbound, $3.95 [6H].

* * *

The Best of
creative computing
Volume 1
Edited by David H. Ahl
creative computing

The Best of Creative Computing

The first two years of **Creative Computing** magazine have been edited into two big blockbuster books. **American Vocational Journal** said of Volume 1, "This book is the 'Whole Earth Catalog' of computers." [6A] Volume 2 continues in the same tradition. "Non-technical in approach, its pages are filled with information, articles, games and activities. Fun layout." —**American Libraries.** [6B] Each volume $8.95.

* * *

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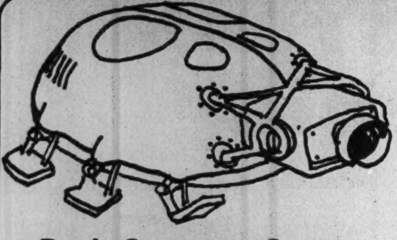
Have You Been Bitten By The Computer Bug?



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Edited by David Ahl, this book contains 101 imaginative and challenging games for one, two, or more players — Basketball, Craps, Gomoko, Blackjack, Even Wins, Super Star Trek, Bombs Away, Horserace. Simulate lunar landings. Play the stock market. Write poetry. Draw pictures.

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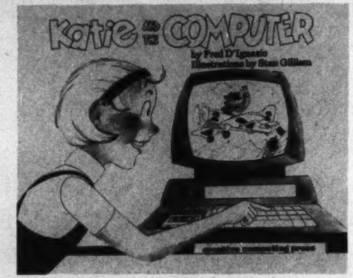
The Best of BYTE

The Best of Byte

This is a blockbuster of a book containing the majority of material from the first 12 issues of Byte magazine. The 146 pages devoted to hardware are crammed full of how-to articles on everything from TV displays to joysticks to cassette interfaces and computer kits. But hardware without software might as well be a boat anchor, so there are 125 pages of software and applications ranging from on-line debuggers to games to a complete small business accounting system. A section on theory examines the how and why behind the circuits and programs, and "opinion" looks at where this explosive new hobby is heading. 386 pp softbound. $11.95 [6F]



Katie and the Computer

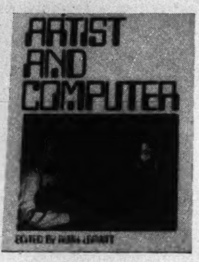
Fred D'Ignazio and Stan Gilliam. This is a delightful story told in words and full color drawings of Katie's adventures when she "falls" into a computer. In Katie's journey through the land of Cybernia she meets the Software Colonel, the Bytes, the Table Manager and even a ferocious Program Bug. Her journey parallels the path of a simple command through he stages of processing in a computer, thus explaining the fundamentals of computer operation to 4-10 year olds. Supplemental explanatory information is contained in the front and back end papers. 42 pp. hardbound $6.95.

creative computing
First Philadelphia Computer Music Festival
Recorded Live

Computer Music Record

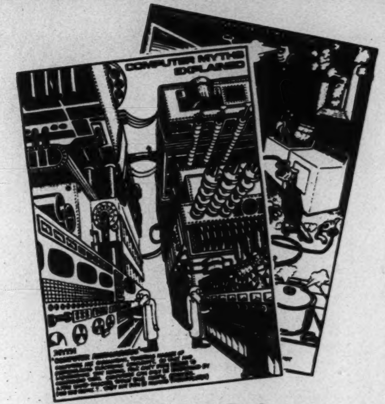
A recording was made of the First Philadelphia Music Festival which is now available on a 12" LP record. It features eight different computer music synthesizers programmed to play the music of J.S. Bach, J. Pachelbel, Rimsky-Korsakov, Scott Joplin, Neil Diamond, Lennon & McCartney and seven others. The music ranges from baroque to rock, traditional to rag and even includes an historic 1963 computerized singing demonstration by Bell Labs. $6.00 [CR101].

More Games, Challenging Problems And Programs Than You Can Shake A Joystick At!



Artist and Computer

This unique book by Ruth Leavitt covers the latest techniques in computer art, animation and sculpture. In its pages 35 artists explain how they use computers as a new means of self-expression. **The San Francisco Review of Books** said "Get yourself a copy of this book if you enjoy feeding your mind a diet of tantalizing high-impact information." Over 160 illustrations, some in full color. 121 pages hardbound [6E] $10.00. Softbound [6D] $4.95.



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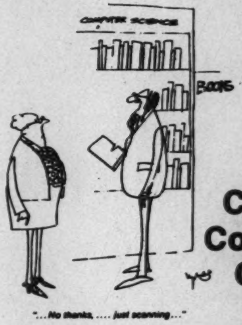

"...No thanks, ... just scanning..."

The Colossal Computer Cartoon Book

The best collection of computer cartoons ever! 15 chapters of several hundred cartoons about robots, computer dating, computers in the office, etc. Great gift item. 128 pp. softbound $4.95 [6G]

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Puzzle Answers.

Ezra Puzzle: "*I* think *it* is a strange custom," said the man with the black *tie*, "and a peculiar *rite*, but a fact that when we *inter* a body, we *retain* a *certain* memory of it. The *creation* of laws concerning *cremation* is proof of its *importance*."

Happy Adding: The answer is 5, derived from subtracting the sum of the even numbers from that of the odd numbers.

Egg and Cannon Ball: You place the egg on the floor, in one corner of the room, in which position the walls on either side make it impossible to touch it with the cannonball.

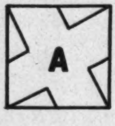
Far A Fields: *One* was going to St. Ives. Remember, the traveler *met* these people on the road so they must have been *coming* from St. Ives. If they had been going to St. Ives he would have *passed* them, not *met* them on the road.

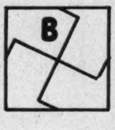
Dictionary Quiz: (1)K, (2)B, (3)M, (4)N, (5)E, (6)H, (7)I.

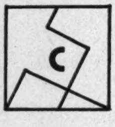
All Work and No Play: PLAY, CLAY, CLAP, CRAP, CROP, COOP, CORP, CORK, WORK.

A Puzzling Inscription: The letter E, which, inserted at the proper intervals, makes the inscription read as under:
PERSEVERE YE PERFECT MEN,
EVER KEEP THESE PRECEPTS TEN.

Don't Be A Square:







Faulty Computing

Parkinson's Law and its various derivations have received considerable attention over the past few years. We are all amused when someone proposes a new law such as, "adding manpower to a late software project makes it later."

Since 1971, the IEEE Computer Society has been sponsoring an annual symposium on Fault-Tolerant Computing and Redundancy Techniques. Suppose the following quotations from several recent papers were presented as so-and-so's new law? We'd all laugh and go our merry way. Well, these aren't new laws; they're real. So stop and think the next time you read the next "humorous" law — it may be more real than you think.

— DHA

"The larger the computer system, the higher the probability of failure."

"Where fault-tolerant computing is most needed to enhance system reliability, it is almost completely absent."

"When a system becomes too complex and has too many interdependent parts, it eventually will collapse."

"Large computer systems have large problems in the areas of reliability, availability, and serviceability."

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- ☐ B. Trs-80
- ☐ C. Apple
- ☐ D. Sorcerer
- ☐ E. Challenger
- ☐ F. PET
- ☐ G. S-100
- ☐ H. Other

4. Your Income:
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- ☐ B. $20-30K
- ☐ C. $30-40K
- ☐ D. $40-50K
- ☐ E. $50K +
- ☐ F. none of your business

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203	208	213	218	223	353	358	363	368	373
204	209	214	219	224	354	359	364	369	374
205	210	215	220	225	355	360	365	370	375
226	231	236	241	246	376	381	386	391	396
227	232	237	242	247	377	382	387	392	397
228	233	238	243	248	378	383	388	393	398
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3. What micro computer, if any, do you own?
- ☐ A. No system at present
- ☐ B. Trs-80
- ☐ C. Apple
- ☐ D. Sorcerer
- ☐ E. Challenger
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- ☐ G. S-100
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4. Your Income:
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102	107	112	117	122	252	257	262	267	272
103	108	113	118	123	253	258	263	268	273
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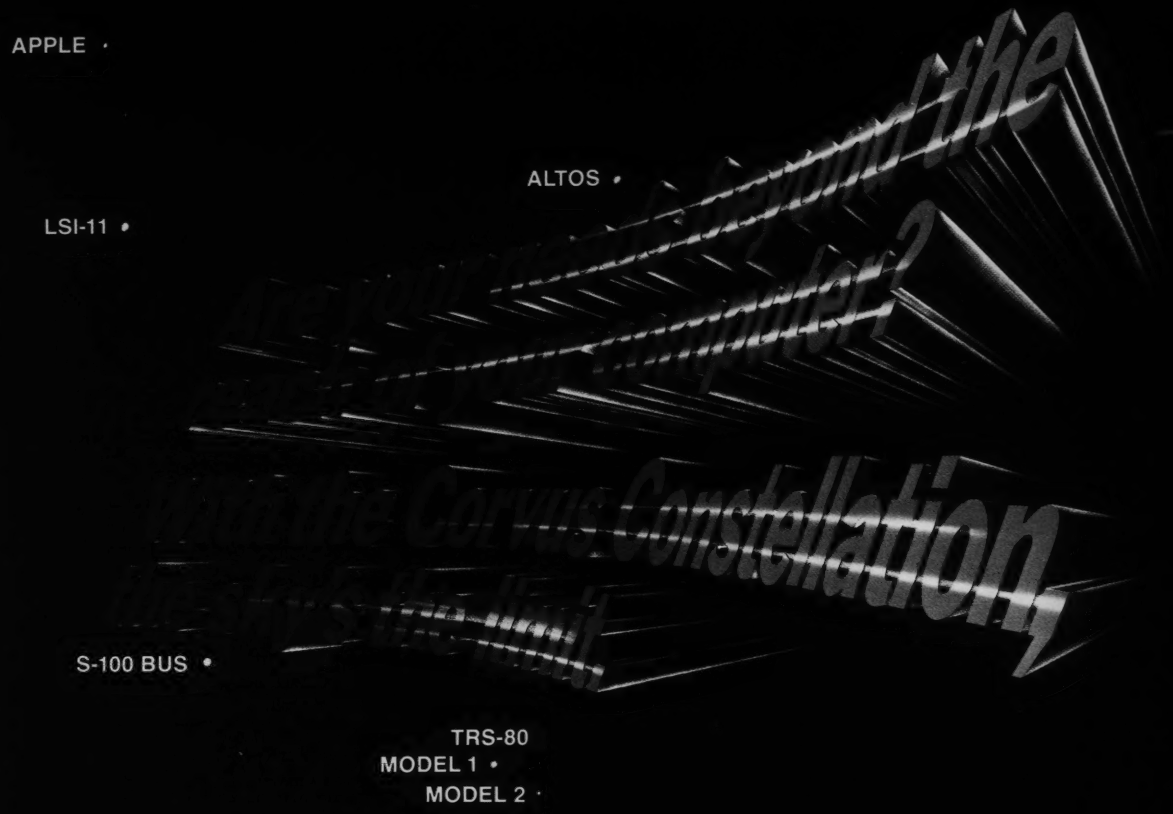
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